Board of Scientific Advice for India

ANNUAL REPORT

FOR THE YEAR

1918-19

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1920

Price Re. 1 or 1s. 6d.

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The Hon'ble Major-General W. R. Edwards, C.B., C.M.G., K.H.P., M.D., I.M.S.	Director-General, Indian Medical Service.
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C. C. Calder, Esq., B.Sc., B.Sc. (Agr.), F.L.S.	Officiating Director of the Botanical Survey of India and Officiating Secretary, Board of Scientific Advice.

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1. The Surveyor-General of India (Chairman);
2. The Director-General of Observatories;
3. The Director, Geological Survey of India.

Sub-Committee B.—(*Agricultural Products*).

1. The Director, Botanical Survey of India (Chairman);
2. The Inspector-General of Forests;
3. The Agricultural Adviser to the Government of India.

Sub-Committee C.—(*Soils and Manures*).

1. The Agricultural Adviser to the Government of India (Chairman);
2. The Director, Geological Survey of India;
3. The Inspector-General of Forests.

Sub-Committee D.—(*Forest Products*).

1. The Inspector-General of Forests (Chairman);
2. The Agricultural Adviser to the Government of India;
3. The Director, Botanical Survey of India.

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1. The Principal, Punjab Veterinary College (Chairman);
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3. The Director, Geological Survey of India;
4. The Director, Zoological Survey of India.

Annual Report of the Board of Scientific Advice for India, 1918-19

SUMMARY OF PROCEEDINGS.

Thirty-sixth meeting held at Simla on the 19th May 1919.

The Board considered the programmes of work of the various Scientific Departments and resolved that, as regards the programme of the Forest Department, an investigation to discover quick-growing species of trees that could be recommended to agriculturists in various parts of India for cultivation as a fuel supply should form part of the programme of work of the Silviculturist, and that the investigation of medicinal products should be omitted from the programme of work of the Forest Chemist as such investigations overlap those to be conducted under the Drugs Manufacture Committee.

In view of the advantages gained by officers meeting at the Indian Science Congress, the Board strongly recommended that the concession of travelling allowance to selected officers to attend the meetings of the Congress should be continued for a period of five years from 1920.

The Board then considered a note by the Director of the Botanical Survey of India on a proposed enlargement of the staff of that Department. The Board regarded the proposals as inadequate and resolved to refer the whole question of the re-organisation of the Botanical Survey to a Sub-committee for report.

Thirty-seventh meeting held at Delhi on the 24th November 1919.

The Board appointed Mr. C. C. Calder to officiate as Secretary during the absence on leave of Lieutenant-Colonel A. T. Gage, I.M.S.

The report of the Sub-committee appointed at the previous meeting of the Board to consider a re organisation of the Botanical Survey was laid before the Board. It was resolved to recommend the adoption of the proposals to Government.

An endorsement from the Government of India, Department of Revenue and Agriculture, forwarding correspondence regarding the participation of

India in the scheme for the organisation and development of scientific and industrial research initiated in the United Kingdom and the proposed severance of relations between India and the Imperial Institute was considered and recorded.

The draft Annual Report was discussed and adopted and the Board accepted a suggestion of the Agricultural Adviser to the Government of India that the publication of half-yearly abstracts of veterinary literature in the Agricultural Journal should be discontinued.

APPLIED CHEMISTRY

PART I.—AGRICULTURAL CHEMISTRY

BY

W. H. HARRISON, D.Sc.,
Imperial Agricultural Chemist.

SOILS.

Soil surveys.—Taylor has completed a traverse soil survey of the tract south of Bhagalpur which reveals a very marked deficiency in phosphoric acid but not of potash. A second traverse survey is in progress.

Norris reports that considerable progress has been made with the survey of the Godavari Delta and that the preliminary work in connection with the Periyar Delta has been completed. In the Punjab Wilsdon is commencing a survey of the Thal.

The study of the soils of orange gardens has been taken up in the Central Provinces and progress has been made with the survey of the tea districts of North-East India by the officers of the Indian Tea Association.

Soil Investigations.—Wilsdon has continued his investigations in connection with the movement of soil moisture on the lines indicated in last year's report. He concludes that the experimental error on a vertical boring is too great to enable deductions to be drawn with sufficient accuracy and is adopting a system of parallel lateral borings from a central observation well.

The Indian Tea Association officers are continuing the work correlating the incidence of mosquito blight on tea with soil composition.

MANURES AND MANURING.

Norris working on the availability of mineral phosphates under paddy soil conditions has demonstrated that, under suitable laboratory conditions, a considerable proportion is rendered soluble. Field experiments in conjunction with green manures (with one very marked exception), however, showed little or no increase in the cropping. Meggitt working on similar lines with a four year sugarcane rotation in Assam concludes that although the effect in the first rotation period is not very marked, it is likely to be greater in the succeeding rotations. He records that these mineral phosphates have given extraordinary good results with Rape and that the use of lime and basic

phosphate on sour soils is indicated. With regard to the employment of lime he concludes that small recurring dressings of lime are preferable to occasional heavy ones and that finely ground lime-stone is almost as efficacious as quick-lime.

Harrison has studied the value of green manures used in conjunction with ammonium sulphate on paddy and the results support the conclusion that the action of the former is largely of an indirect character and the maximum benefit is obtained when used in conjunction with direct manures. The study of the value of green manures in connection with Ragi (Eleusine coracana) cultivation has been continued by the Mysore Department and the results obtained are confirmatory of the conclusion previously reported that a considerable loss occur through the liberation of famous nitrogen. The attention of this department is also directed to the effect of nitrogenous manures on the spike of sandal.

Padmanabha Iyer has investigated the manurial requirements of the Bhatta soil of the Chattisgarh District of the Central Provinces and has observed that manuring with superphosphate combined with inoculation with black cotton soil emulsion has stimulated the growth of sunn hemp.

Harrison has studied the phenomenon of the retention of superphosphate in calcareous and non-calcareous soils and has demonstrated that absorption is the determining factor with the latter and chemical combination with the former. He has also shown that the effective range of super in calcareous soils is very restricted when compared to the wider range in non-calcareous soils, leading to the conclusion that the problems connected with phosphatic manuring are very different in the two types of soil.

CROPS.

Sugarcane.—B. Viswanath of the Madras Department has developed a method for the determination of the Refractive Index of small quantities of juice extracted from growing sugarcanes. Correlation of these values with the growth of the cane and the composition at ripeness shows that the method may be used to ascertain the best time for cutting canes and that it has considerable value in determining the relative value of cane seedlings at a very early stage of growth. Meggitt has also studied the changes taking place in the canes during the ripening period.

Harrison repeated his observations upon the effect of windrowing canes in the North-West Frontier Province upon a larger scale. The results confirm the previous conclusions regarding quality and quantity of juice and have shown clearly that there is an actual increase in the amount of sucrose and crystallizable sugar obtainable. The period over which the cane can be stored without deterioration occurring would appear to be determined by the incidence of heavy rainfall. In both years the canes rapidly deteriorated after the first heavy fall experienced after windrowing.

Sugar from Palms.—Taylor has made a study of the sugar content of palmyra juice and V. G. Gokhale in Bombay has investigated the production of jaggery from the date and fan palms of Western India. Both of these officers have prepared their observations for publication.

Spices and Betel.—D. L. Sahasrabuddhe of the Bombay Department has continued his investigation regarding the deterioration of cardamom plants under continued garden cultivation and has made the important observation that partial sterilization by heat allows cardamom plants to be produced from the rhizomes as healthy as those grown from seed or grown in virgin soils. V. G. Patwardhan has studied the action of manures on the quality and composition of the essential oil of betel leaves.

General.—The effect of different climatic conditions on the hydrocyanic acid content of jowar (A. sorghum) has been under observation in Taylor's laboratory and certain of the results were published in the Agricultural Journal of India.

The study of the factors influencing the Morphine content of opium has been continued by Annett and his staff and two papers have been published, one dealing with effect of heat on opium and its constituent alkaloids and the other with the method of estimating morphine. Incidentally the value of poppy seed cake as a cattle food was under review with the result that no deleterious effects on the yield of milk and the composition of Butter Fat were observed.

Experiments to determine the amount of malt extract derived from cholam (A. sorghum) carried out by Norris show that this varies with the type of cholam employed and the conditions under which the malting takes place. With the best types extracts equal to those from barley malt have been obtained.

APPLIED CHEMISTRY

PART II.—FOREST CHEMISTRY

BY

J. L. SIMONSEN,

Forest Chemist, Forest Research Institute, Dehra Dun.

Owing to the absence on leave of Mr. Puran Singh work at the Forest Research Institute, Dehra Dun, has during the period under review been confined mainly to ordinary routine analysis. No research work of any importance has been undertaken.

Wood Distillation.—An important paper on Wood Distillation has appeared in the Journal of the Indian Institute of Science, Volume 2, Part VII, pages 79-119. In this paper Drs. Sudborough and Watson reviewed at considerable length the economic aspect of wood distillation as applied to India and in the second half of the paper they give a detailed account of the results obtained by the distillation of Indian woods.

Tanstuffs.—Mr. Pilgrim has been engaged during the major part of the year at the Esociet Tannin Research Factory at Maihar where he has worked in collaboration with Mr. Fraymouth. The results of their work on simple and mixed tanstuffs have been published in a monograph issued by the Indian Munitions Board.

Essential Oils and Oleo-Resins.—The leaves of *Cinnamomum glanduliferum* have been distilled at Dehra Dun by Mr. Ghosh. The yield of camphor (0·20 per cent.) and of camphor oil (0·44 per cent.) is rather poor. It is proposed to examine further samples of these leaves and also to investigate the constituents of the oil.

Eucalyptus tereticornis and Eucalyptus crebra.—Leaves of these two species of *Eucalyptus* were collected from trees growing at Kaunli, Dehra Dun. The oils obtained resembled those from similar species grown in Australia. The oil from *Eucalyptus tereticornis* contained a small percentage of eucalyptol which was, however, absent from the oil of *Eucalyptus crebra*. Neither oil complies with the standard of the British Pharmacopœia.

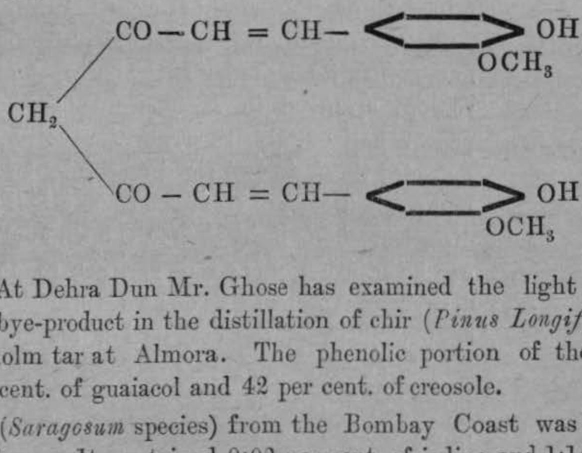
Oleo-Resin of Dipterocarpus indicus.—The oleo-resin of *Dipterocarpus indicus* has been examined at the Indian Institute of Science (Mansukhani and Sudborough, Journal of Indian Institute of Science, Volume II, Part IV, pages 37-45). The essential oil consisted mainly of γ and β Caryophyllene

and resembles Copaiba oil. It is possible that it may be used for medicinal purposes in place of this oil. The resin after removal of the oil yields both spirit and oil varnishes of good quality.

Oleo-Resin from Hardwickia pinnata.—The oleo-resin has been investigated by Sitaram Iyer and Sudborough (Journal of Indian Institute of Science, Volume 2, Part III, pages 29-35). The essential oil consists mainly of L Caryophyllene, β Caryophyllene being absent. The resin makes good oil and spirt varnishes.

Natural Dyestuffs.—The writer (Journal of the Chemical Society, 1918, *113*, 766-774) has investigated the constitution of the dyestuff morindone obtained from the root bark of the *Morinda citrifolia*. It is suggested that morindone is either methyl hydroxyanthrarufin or methyl hydroxychrysazin, the former being the more probable.

The constitution of the dyestuff curcumin obtained from *Curcuma longa* has been definitely settled by its synthesis by two independent investigators, Lampe (Berichte Deut. Chem. Gesell. 1918. *51*, 1347) and P. C. Ghose (Journal of Chemical Society, 1919, *115*, 292). It has been shown to have the following constitution.



Miscellaneous.—At Dehra Dun Mr. Ghose has examined the light chir tar oil obtained as a bye-product in the distillation of chir (*Pinus Longifolia*) stump wood for stockholm tar at Almora. The phenolic portion of the oil contained about 8 per cent. of guaiacol and 42 per cent. of creosole.

A sample of Kelp (*Saragosum* species) from the Bombay Coast was also examined by Mr. Ghose. It contained 0·02 per cent. of iodine and 1·14 per cent. of potassium.

ASTRONOMY

BY

G. C. SIMPSON, D.Sc., F.R.S.,

Officiating Director-General of Observatories.

Solar physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikanal, the Director being Mr. J. Evershed. The Assistant Director Dr. T. Royds was engaged on war work under the Indian Munitions Board throughout the year.

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikanal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the centre of the dark line is frequently "reversed," *i.e.*, is bright instead

of dark indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds called "flocculi" of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the "prominences" projecting from the sun's margin.

(*b*) An autocollimating spectroheliograph built in the observatory workshop. This is attached to the side of the Cambridge instrument and shares in the very perfect transverse movement of the latter. It is designed for photographing the sun's disk in the hydrogen line C. A large grating is used to obtain the highly dispersed spectrum which is necessary in photographing with this line.

(*c*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and for accurate guiding during long exposures on sunspots or prominences. A special device has also been added for photographing simultaneously the spectrum of an electric arc on either side of a solar spectrum. A grating by Anderson with 5-inch ruling is usually employed.

(*d*) A 6-inch equatorial refractor with large grating spectroscope attached is used for the study of sunspot and prominence spectra by visual methods. The equatorial mounting and spectroscope are from the Maharaja Takhtasingji Observatory Poona.

(*e*) A 6-inch equatorial refractor by Cooke for general work. Repaired and remounted after its return from Kashmir.

(*f*) A 6-inch photoheliograph mounted in the North Dome.

(*g*) The 15-inch lens borrowed from the Nizamiah Observatory, Hyderabad, is in use for photographing the spectrum of venus and for solar spectra.

Routine Work.—Daily spectroheliographic records are obtained in calcium and in hydrogen light; the routine work also includes visual examination of sunspots and faculae, sunspot spectra, and bright lines or displaced lines in spots and in prominences. A monthly article describing the solar activity is contributed to the "Monthly Weather Review" while for more technical purposes bulletins and memoirs of the observatory are issued. Of the former 60 have appeared and of the latter 2 have been published.

SPECTROSCOPIC RESEARCH.

1. Spectra of Venus and Fe arc were secured during 1918 until September 9. After the superior conjunction of Venus with the sun on November 24, photographs were obtained on 42 evenings between January and July 1919. During the months of January, February, and March a slight movement of the grating which could not be prevented unfortunately vitiated all of the 28 plates taken during those months, and some of the April plates. The trouble was finally traced to the action of the afternoon sun heating a wall, which by its expansion caused a rotation of the grating amounting to about 1 second of arc. The difficulty was entirely removed by cutting a gap in the wall separating it from the building containing the Spectrograph.

2. Excluding the plates taken during the first 3 months of 1919 which yield anomalous results, measures of the 1918 and 1919 series of Venus plates, and of control plates of ordinary sunlight and Fe arc, give very remarkable and interesting results. Both series agree in showing smaller wave-lengths in the solar iron lines reflected by Venus compared with those in ordinary sunlight and as the angle Venus-Sun-Earth increases the wave lengths diminish.

3. This appears to prove that the well known Sun-arc displacements of the lines are only found in light derived from a hemisphere of the Sun facing towards Earth. If the light is taken from a hemisphere turned 90° from the direction of the Earth, the displacement appears to be *nil;* and if this angle exceeds 90° the measures indicate a shift of the solar lines towards violet, instead of towards red as in ordinary sunlight.

4. As these results imply an Earth effect on the Sun it is very desirable to obtain ample confirmation of them, and to test also the constancy of the Sun-arc shifts in ordinary sunlight. Measures of these shifts are made at Kodaikanal at least twice monthly and the results show that small variations do occur, but it is at present doubtful whether these are of solar origin, the changes are much smaller than those observed in the Venus spectra.

5. This research has yielded as by-products two other interesting results. Strong evidence has been obtained that the planet rotates in the same direction and with the same order of velocity as the Earth, and, secondly, a marked difference has been found in the relative intensity of the green and violet regions of the spectrum in Venus compared with a brightly illuminated terrestrial cloud. This suggests that the atmosphere of Venus is either cloudless, or if cloud covered as is generally believed, then the atmosphere above the clouds must be strongly absorptive for violet light.

6. The spectra of Nova Aquilae obtained in 1918 have been measured and studied in detail. The enormous velocity in the direction of the Earth of the absorbing hydrogen and iron vapour is shown to be only 2 or 3 times greater than velocities of hydrogen frequently observed in the sun. The changing wave-lengths of the displaced absorption lines of hydrogen and

iron, indicating accelerating motion, suggest an analogy with the solar eruptive prominences; and it is considered that this is due to the repulsive force of light pressure acting strongly in the earlier stages of the Nova outburst. The emission bands of hydrogen are found to have widths proportional to wave-length, proving that pressure is not concerned in the widening. This is probably a Doppler effect also, due to a vast expansion of the hydrogen in all directions.

7. A large proportion of the absorption lines observed on June 13, at the intermediate stage between a typically dark line and a bright line spectrum, are shown to coincide with the enhanced lines of iron, titanium, etc.; when allowance is made for their displacements towards violet, which are nearly the same as in the hydrogen series of lines. The narrow absorption lines of calcium at later stages are shown to have a displacement which is the same in amount and sign as that which would be due to the solar motion in space, implying that the tenuous calcium vapour is stationary with respect to the star system and probably has no connection with the Nova. The enormous velocities observed in the expanding hydrogen (up to 2480 km/sec) can only be explained as the result of a collision or, perhaps more plausibly, by the release of the enormous internal energy of atoms, implying the actual destruction of matter in the interior of the star.

METEOROLOGY

BY

G. C. SIMPSON, D.Sc., F.R.S.,

Officiating Director-General of Observatories.

Upper Air.—In the absence of both the Director and his Assistant on war work, no examination or publication of the data already collected was possible. Pilot balloon work at three stations in North India and one in the south was continued on the same scale as during 1917 to 1918, and a survey of the winds along the flying route to Rangoon was started by the institution of a balloon station at Akyab in February 1919. The preparation of the data for publication was continued.

The Aerological Observatory provided assistance in connection with the Military pilot balloon work of Mesopotamia by supplying hydrogen and apparatus.

General Meteorology.—Owing to the absence of the scientific members of the staff on war work, research was at a standstill during the year.

TERRESTRIAL MAGNETISM

BY

G. C. SIMPSON, D.Sc., F.R.S.,

Officiating Director-General of Observatories.

Magnetic observatories.—Bombay (Alibag).—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city. It is now directly under the Government of India, the Director being Dr. N. A. F. Moos. For a description of the instruments and of the routine work reference should be made to the Annual Report of the Director.

Magnetic Survey.—No. 18 Party—Magnetic.—The magnetic observatories at Dehra Dun and Toungoo were inspected by the officer in charge during the field season and a complete set of observations was taken at each for the comparison of instruments. The Alibag and Kodaikanal Observatories were also visited for the same purpose.

No field observations were taken during the year.

Periodical observations are necessary at "repeat stations" in order to obtain reliable values of the annual changes in the magnetic elements, as it is not possible to predict with any accuracy what the annual changes will be even for a few years in advance. It has, therefore, been decided to take observations at intervals of 5 years, as recommended by the Survey Committee of 1914. The 75 permanently marked "repeat stations" were last observed at in 1914-15 hence observations at these stations will be repeated during the ensuing field season, November 1919 to April 1920.

Special observations.—In response to an appeal by Dr. L. A. Bauer, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, to all magnetic observatories for co-operation in special simultaneous magnetic observations in connection with the Total Solar Eclipse of May 29, 1919, observations were taken at the Dehra Dun Observatory on the 28th, 29th and 30th of May 1919, in accordance with the programme issued with Dr. Bauer's letter. All observatories, both inside and outside the zone of visibility of the eclipse, were asked to participate in the observations. The Dehra Dun Observatory falls outside this zone. No unusual changes have been noticed in the magnetic elements during the three days' observations, but even a result of this nature will be useful to Dr. Bauer, to whom the observations are to be forwarded, in the investigation of the effects of the eclipse on the magnetic elements.

Publication of the results of the Magnetic Survey.—The publication of the results of the Magnetic Survey from 1901 to 1915, reduced to the epoch 1909-10, will take place shortly. The printing of the tables of the magnetic elements is complete, maps, etc., are ready and the remainder of the work should not take long.

The reduction of the observations of the detailed survey and the investigation of the results in disturbed areas are being proceeded with.

The magnetic elements at observatories.—The computation and tabulation of the provisional values of declination, dip, horizontal force and vertical force for the three observatories (Dehra Dun, Toungoo and Kodaikanal) for 1918 have been completed; the mean values of these elements for the year 1918 derived from all days, excluding those of great disturbance, are given in the table below:—

Observatory.	Latitude and Longitude.	Dip.	Declination.	H.F.	V.F.
	° ′ ″	° ′	° ′	C.G.S.	C.G.S.
Dehra Dun ...	30 19 19 N 78 3 19 E	N. 44 49·6	E. 2 1·4	·32980	·32782
Toungoo ...	18 55 45 N 96 27 3 E	N. 23 8·4	W. 0 16·5	·39067	·16696
Kodaikanal...	10 13 50 N 77 27 46 E	N. 4 30·3	W. 1 39·2	·37694	·02969

GEOLOGY

BY

H. H. HAYDEN, C.I.E., F.R.S., D.Sc., F.G.S.,
Director, Geological Survey of India.

Petrology.—In his account of the geology and coal resources of Korea State, Central Provinces, Dr. Fermor described some puzzling rocks under the name of the Chirmiri volcanic series. Subsequent work on the Bokaro coalfield showed that these rocks were the products of the fusion of shales and sandstone due to the burning of coal-seams at the outcrop. Dr. Fermor has now studied the microscopic aspects of these products and finds them to consist of vitrophyric rocks containing crystals of various minerals in a glassy base, amongst the minerals recognised being cordierite, sillimanite, pyroxenes, plagioclase, black ores, and a mineral closely allied to fayalite. These rocks show the structures and textures of volcanic rocks; but on account of their production from sediminetary rocks with resultant peculiarities in chemical and mineral composition, Dr. Fermor designates them *para-lavas* on the analogy of the terms para-schist and para-gneiss.

Palaeontology and Stratigraphy.—Descriptive work on Tertiary fossil Gastropoda has been continued by Mr. Vredenburg. A considerable section of the Upper Gondwana type fossils, originally described by Dr. Feistmantel, has been revised by Prof. Seward and Dr. B. Sahni; the results have now been received, and will be published shortly in the *Palæontologia Indica.*

The recent discovery of Tertiary fossils on the ridge between the Shali peak and Matiana, near Simla, will necessarily lead to a revision of the prevailing views with regard to the distribution of the Tertiary rocks of the outer Himalaya. The fossils now discovered include nummulites, which appeared to be of early eocene age, and it seems probable that the rocks in which they occur represent an outlier of the Subathu beds of Solon.

Geological Surveys.—The geological survey of Tavoy was completed, and that of Mergui continued during the year. Surveys were also made of parts of the ferriferous belt of Bihar and Orissa, and a considerable amount of information has been collected regarding the Archaean rocks of that and neighbouring areas.

Economic Enquiries.—Investigations were made regarding the following minerals:—antimony in the Southern Shan States, chromite in Singhbhum, coal in the Arakan Yoma, gold in Putao (Upper Burma), iron in Singhbhum

and Orissa, kaolin in Delhi and in Burma, lead in Putao, soda in Sind, sulphur in Baluchistan and the Persian Gulf, tin in Lower Burma, tungsten in Lower Burma and in Singhbhum.

Energetic measures were continued for the encouragement of mica-mining throughout the country, and a group of mines was successfully worked by the Geological Survey Department on behalf of the Government of Bihar and Orissa.

GEODESY

BY

COLONEL SIR GERALD LENOX-CONYNGHAM, R.E., F.R.S.,
Superintendent of the Trigonometrical Survey.

The only Geodetic work done during the year consisted of Tidal Observations and Precise Levelling; no Triangulation was undertaken nor were any Pendulum or Astronomical Observations made.

LEVELLING OPERATIONS.

Mesopotamia.—A party of 4 levellers was sent to Mesopotamia in the Autumn of 1918. The object of the levelling was primarily to provide trustworthy bench marks for the use of irrigation engineers, but should geodetic operations be undertaken in that country these lines of levels will be of value.

The lines run were :—

(1) From Basrah to Nāsarīyah, along the railway, thence northwards *viá* Samāwah to Hillah along the Hillah branch of the Euphrates, and finally, leaving the Euphrates, to Bāghdād.

(2) From Bāghdād to Kut-al-'Amarah and thence to Shaikh Sa'ad where a junction was made with a good line run in 1916-17 up the Tigris from Basrah by a party of levellers sent from India by the Public Works Department.

(3) From Kut-al-'Amarah *viá* Hai along the Shatt-al-Gharrāf to Suwaij and thence by road to Nāsarīyah.

(4) From Bāghdād to Ramādi *viá* Fallujah.

(5) From Bāghdād to Table Mountain along the railway line.

(6) From Bāghdād to Baiji (Rail head) along the railway line.

Lines (1), (2) and (3) form two circuits, namely :—

(*a*) Basrah-Nāsarīyah-Kut-al-'Amarah (*viá* Hai)-Shaikh Sa'ad-Basrah. Length 526 miles.

The closing error of this circuit amounted to —0·593 ft. The circuit includes several river crossings and the closing error, though greater than would be expected from the length of the lines, is on the whole tolerably satisfactory.

(*b*) Nāsarīyah-Samāwah-Hillah-Bāghdād-Kut-al-'Amarah Nāsarīyah. Length 482 miles.

The closing error of this circuit amounted to + 0·141 ft. This result is very good. The probable error calculated by the formula which has been found applicable to the Indian work is ± 0·186 ft.

The heights of the Bench Marks have all been expressed in terms of Mean Sea Level at Fāo. The height of Mean Sea Level at Fāo was deduced from readings of a tide gauge set up under the direction of Sir G. Buchanan and a line of levels was run from this tide gauge to Basrah by the P. W. D. levellers already alluded to. The precise levelling starts from one of the bench marks fixed at Basrah by the line from Fāo, and therefore if the determination of Mean Sea Level was not very precise, or if the levelling from Fāo to Basrah was not very accurate, (though there is no reason to suppose so), the datum of the heights of the bench marks in Mesopotamia may not correspond precisely with true mean sea level at Fāo. This was considered to be of no importance. The mean level of the sea at Fāo is most unlikely to form part of the level surface to which the mean level of the ocean conforms and there is therefore nothing to be gained by finding out with great precision the relation between the height of the water at Fāo and of points on land. If in the distant future precise levelling be carried along the shores of the Persian Gulf and down to the Karachi Tidal Observatory there will be considerable interest in finding out by how much the mean level of the Gulf differs from the mean level of the Ocean, but for this purpose the height of mean sea level at Bushire, where an automatic Tide Gauge was established in 1892 and maintained for 7 years, is available, and its situation is superior to that of Fāo for the purpose in question.

As the nature of the soil at Basrah is not such as to offer much certainty of stability in the bench marks built there, a Standard Bench Mark and four auxiliaries were built in the neighbourhood of Zubair, where the ground is safe from inundation and where good stability may be expected, and a good connection was made between the Basrah bench marks and this Zubair group. Repetitions of the short line Zubair-Basrah made from time to time will show whether the ground round about Basrah is moving or not.

Punjab.—In April 1919 two levellers were sent to revise the line from Pathānkot, 1081 feet above Mean Sea Level, to Dharmkot hill (Dharamsāla), 7136 feet above Mean Sea Level, a distance of 56 miles, in order to ascertain whether the seismic disturbance which occurred in that locality in the summer of 1916 had had any effect on the relative levels of the hills and plains. The test was made possible by the existence of carefully selected bench marks laid down and connected in April and May 1910 with a view to such a contingency.

In order to make the two levellings as strictly comparable as possible the repetition of 1919 was made at the same time of year as the original levelling of 1910, and as far as was feasible the conditions of 1910 were reproduced.

The terminal discrepancy between the results of the 1910 and the 1919 levellings was found to be—0·246 of a foot; of this amount 0·097 ft. was generated in the first 44 miles from Pathānkot, in which the rise is 1088 feet and the remaining 0·149 ft. in the last 12 miles, in which there is a steady rise of 4967 feet.

It is worthy of note that the total difference between the results of the two levellers amounted to 0·214 ft. in 1910, and to 0·248 ft. in 1919. These quantities are very nearly equal to the total discrepancy between the mean results of the 1910 and the 1919 observations. The result by one of the levellers of 1910 was practically identical with that of one of the levellers of 1919.

It is therefore safe to conclude that the discrepancy of —0·246 ft. is due to the errors, accidental and systematic, which are inherent in the conditions of mountain levelling and that no measurable change has resulted from the earthquake of 1916.

TIDAL OPERATIONS.

The tidal operations were normal and call for no special remark. The same tidal observatories as last year were in operation namely:—Aden, Karachi, Bombay, Madras, Kidderpore, Rangoon, Moulmain, and Port Blair.

Readings of the tide-pole at Basrah have been continued under the orders of the Director of Inland Water Transport and from them the Harmonic Analysis for the determination of the constants of the Port has been performed.

PUBLICATION.

From the geodetic point of view the most interesting event of the year was the publication of Professional Paper No. 17 by Colonel Sir Sidney Burrard, K.C.S.I., R.E., F.R.S.

The title of this paper is *Investigations of Isostasy in Himalayan and Neighbouring Regions* and it puts forward the proposition that the anomalies both in the values of g and in the attractions of the plumb line, which remain after the effects of isostatic compensation on the Hayford hypothesis have been allowed for, may be due to imperfections in the application of the hypothesis rather than to departures from complete compensation. Hitherto in computing the compensation all masses standing above the mean level of the sea have been assumed to have a density of 2·67 (mean density of the earth's surface); if however the rocks over any area are known to be for considerable depths of an appreciably different density it is only reasonable to take account of this difference in deducing the density of the compensating mass, just as in the case of ocean areas the presence of the sea water is taken account of.

Sir Sidney Burrard's discussion is chiefly concerned with the Gangetic trough, over which area of deep alluvial deposits the gravity anomalies are generally negative, whereas in the Himalayas to the north, and along the

margin of the trough to the south, they tend to be positive. His argument is clearly given in the following passage :—

"If the Gangetic trough contains light deposits to a considerable depth, and if the light density of these deposits is isostatically compensated to a depth of 113 kilometres by equivalent heavy density in the crust, the gravity anomalies at stations over the trough will be negative, because the light deposits are nearer to the surface than the deep heavy rocks, which form the compensation : the light rocks thus having a more immediate effect on the pendulum than the heavy.

"On the other hand the light deposits will have no appreciable effect at stations north and south of the trough, whilst the heavy compensation-rock will increase the intensity of gravity at these stations and will tend to make their anomalies positive. A pendulum is actuated by the vertical component of gravity : the vertical component due to surface rock deposits, situated in a horizontal direction to one side of the pendulum, will be very small, but the vertical component of the compensation rocks situated at a great depth will be considerable.

"It is in this way that the hypothesis of isostatic compensation, if applied to the Gangetic trough, may explain the presence of positive anomalies north and south of the trough."

The reduction of these ideas to figures presents formidable difficulties, for we do not know either the shape or depth of the Gangetic trough nor in general the depth to which any particular formation extends, but the need for considering the density of the masses underlying our stations of observation and of the effects of anything abnormal in this density on the deeper parts of the compensating column, had not I believe been appreciated before, and Sir Sidney Burrard has rendered another important service to Geodesy by showing how these considerations tend, at any rate, to explain the anomalies both of pendulum and plumb line observations.

BOTANY.

I.—BOTANICAL SURVEY.

By

C. C. CALDER, B. Sc., B. Sc. (Agr.)., F. L. S.

Officiating Director, Botanical Survey of India.

Eastern India.—Dr. H. G. Carter, Economic Botanist to the Survey, continues his work on the economic plants of Eastern Bengal and Assam. The results of his tours in Upper Assam are now in the Press in the shape of a paper on the Plants of the Lakhimpur District, which should appear at an early date. The Forest Flora of Assam is being studied by Rai Upendranath Kanjilal, Bahadur.

The plants referred to in last year's report as collected by Mr. P. M. Debbarman of the Botanical Survey have now been worked out and several new records for the area in which they were collected, obtained.

Dr. P. Bruhl, Professor of Botany, Calcutta University, is at present engaged in a critical examination of the grasses of the genus *Paspalum*. His work, so far, goes to show that there has been considerable confusion in taxonomic work on this difficult group and attempts are being made to reduce to order the chaos of synonymy which exists probably to a greater extent in the grasses than in any other group of flowering plants. He has also had under revision amongst others the genera *Lindenbergia, Limnophila, Adenosma* and *Stemodia*. When possible material from Sibpur which might help him has been placed at his disposal.

Mr. J. Hutchinson of Kew and Messrs. W. W. Smith and W. G. Craib of Edinburgh add from time to time, descriptions of new or rare Indian plants to the journals to which they usually contribute. Several new acanthaceous plants chiefly from collections by Mr. Kingdom Ward from Upper Burma have been described by Mr. Smith, while Mr. Craib has added some half a dozen new Primulas to the Flora of the North-East Himalaya. Mr. Cooper's collections in Bhutan yielded most of these latter as also a rare *Scabiosa* described by Mr. Hutchinson.

In connection with the proposed extension of the Cinchona plantations to Burma, Lieutenant-Colonel A. T. Gage accompanied by Mr. P. T. Russell, Manager of Mungpoo Plantation, toured in the Tavoy District of Southern Burma during the spring of 1919. Occasion was taken during the tour to collect and preserve some 200 specimens representative of the local flora

Time has not yet been found to undertake the examination of this collection, but from a district so little known as Inner Tavoy there should be promise of good reward in the shape of new or little known plants.

A list of South Tenasserim plants in part worked out in the Herbarium of the Royal Botanic Garden, Sibpur, has been added by Mr. C. G. Rogers, Chief Conservator of Forests, Burma, to his note on a tour of inspection in South Tenasserim. Mr. Gamble has dealt with the bamboos collected by Mr. Rogers.

During several months of the year under review Mr. H. H. Haines, late Chief Conservator of Forests, Central Provinces, worked at Sibpur on a Flora of Bihar and Orissa. In the course of his work several new species now under publication in the Journal of the Asiatic Society, were found and described.

Northern India.—Mr. W. G. Craib has published an account of a hitherto unobserved species of *Primula* from Kashmir, Mr. S. A. Skan has described and figured *Ipomoea dasysperma* Jacq., a plant probably only truly native of East Africa but now widely distributed and occurring amongst other places, in Northern India. Its first recorded appearance was in the Calcutta Botanic Garden in 1812. Additions to his list of Mussoorie plants have been made by Mr. G. O. Allan while the liverworts of the Western Himalayas and the Punjab form the continued study of Mr. S. R. Kashyap. Whilst engaged on an examination of the genus Mr. R. S. Hole found and described a new *Tamarix* from Baluchistan.

Western India.—Mr. L. J. Sedgwick's accounts of *Trichodesma indicum* and *Trichodesma amplexicaule* and descriptions of a new *Impatiens* and *Habenaria* all from Western India, are now under distribution in the Records. A paper on the species of *Zizyphus* in the Bombay Presidency by the same author bears evidence of the advantages gained by close observation of these difficult plants in the field. The group has puzzled more than one botanist who has had to contend with them in the dried state only.

In 1890 Sir David Prain published an account of the plants of the Maldive and Laccadive Islands. Mr. W. B. Hemsley in a paper to the Kew Bulletin now draws a comparison between this flora and that of the Aldabra group in the mid Indian Ocean.

South India.—The study of the Flora of this region of India is emphasised in the work of Mr. Gamble, Mr. Fisher, Professor Fyson and Mr. K. Rangachari. Part II of the Flora of the Madras Presidency including the families Celastraceae to Leguminosae-Papilionatae has now appeared. A preliminary note on the Flora of the Anaimalais by Mr. Fischer has issued and his full account is in hand for the Press. Mr. Rangachari and Mr. Tadulingam have published a note on an undescribed species of *Cynodon* and the Rev. C. Auglade continues his systematic and oecological study of the Floras of the Madura District and Pulney Hills.

General.—The Rev. Father Blatter, in addition to the botanical work frequently referred to in former reports, has been engaged on a comprehensive list of plants of Baluchistan. The first part of his Flora Arabica, a work which attempts to embody all the information available regarding the systematic botany of Arabia, is ready for distribution. Under his guidance a study of the grasses of the Western Presidency is being undertaken by his assistant Mr. C. McCann. A monograph of the genus *Eriocaulon* comprising all the hitherto known and several new Indian species awaits the relief of pressure on the Press, and Professor Fyson has also had under revision the South Indian Glochidions.

An illuminating paper on plant oecology and its bearing on problems of economic importance was the subject of Mr. R. S. Hole's presidential address to the Botanical Section at the fifth Indian Science Congress meeting. Mr. H. H. Haines has published a useful account with photographs of the much confused Indian Carissas.

Through the kind permission and by the assistance of Col. Evans, formerly Director of Agriculture with the Mesopotamia Expeditionary Force, the writer was enabled to undertake a short botanical tour in the region of Mesopotamia near Mosul. Some hundreds of specimens representative of the spring flora of Upper Mesopotamia were collected and the present Director of Agriculture, Lieutenant-Colonel Graham, has added valuable material which will very considerably augment the list it is proposed to give. The writer's account of the species of *Oxalis* now wild in India and of a new Indian *Vernonia* appeared in Volume VI, Part 8 of the Records of the Botanical Survey during the year.

BOTANY.

II.—ECONOMIC BOTANY.

Part I.—Agricultural Botany

BY

ALBERT HOWARD, C.I.E., M.A., A.R.C.S., F.L.S.,

Imperial Economic Botanist.

The present report, which is confined to four pages of print, deals with the progress of Economic Botany in India during the year ending June 30th, 1919. Under these conditions as regards space, the best course would appear to be to limit this paper to an account of the more important advances made during the year and to refer the student of Indian agriculture to the various other annual reports published by Government which cover the same subject but in greater detail.

In addition to the list of papers on Economic Botany appended to this report, the following annual publications contain a considerable amount of information on the improvement of crops :—

(*a*) *Report on the Progress of Agriculture in India.*—This is an annual report, prepared by the Agricultural Adviser to the Government of India, Pusa, Bihar, and deals, among other matters, with the distribution of improved seed in the various parts of India.

(*b*) *Scientific reports of the Agricultural Research Institute, Pusa* (including the Report of the Imperial Cotton Specialist). Copies can be obtained from the Director, Agricultural Research Institute, Pusa, Bihar.

(*c*) *Administration reports of the Provincial Departments of Agriculture* —Bombay, Bengal, Madras, Central Provinces, United Provinces, Punjab, Bihar and Orissa, Assam and Burma. These are issued by the Government presses in these Provinces towards the end of each year and contain a general summary of the work of the Agricultural Department (including the farm reports) of and also the annual reports of the Economic Botanists. These administration reports largely form the basis of the annual *Report on the Progress of Agriculture in India.*

(*d*) *Proceedings of the Board of Agriculture in India.*—This contains the programmes of work in progress in Economic Botany as well as discussions on matters relating to the Agricultural Department as a whole. Copies can

be obtained from the Agricultural Adviser to the Government of India, Pusa, Bihar.

Cotton.—During the year, the report of the Indian Cotton Committee was published. The various aspects of cotton have been dealt with Province by Province and considerable space has been devoted to the opinions of the Committee on the botanical side of the improvement of this crop and particularly to the vexed question of the profitable production of long staple cotton in India.

For some years past, work has been in progress at Cawnpore on the improvement of Cawnpore-American cotton, the results of which have just been published by Burt and Nizamuddin Haider. These investigations were started in 1913 and are being continued. Various pure lines have been isolated, multiplied and tested on a field scale while the lint has been subjected to tests by experts. Attention has also been paid to the study of the chief factors involved in cotton growing in the middle Doab, to the distribution of seeds, to the marketing of the produce and to improvements in cultivation. As regards the quality of the improved types, the expert brokers of the British Cotton Growing Association report that "the Ca 7, 9 and 18 are very good and are cottons which could be used extensively in Lancashire and if India could produce any quantity there should be an excellent demand. . . .

These qualities are, of course, a great improvement on the samples of Punjab-American 4 F."

Some other papers on cotton improvement have appeared during the year which deal mainly with the difficulties which have to be overcome in replacing the country crop by an improved type. Thomas describes in detail the labours of the Madras Agricultural Department in establishing an improved cotton (isolated by Sampson) in the Tinnevelly tract which comprises the three southernmost Districts of the Presidency where about 600,000 acres are grown. Seed is distributed chiefly by means of village seed unions each of which has its own seed farm, the system closely following the lines originally devised by Clouston in the Central Provinces. In the replacement work, it was found necessary for the Agricultural Department to join forces with the local firms and the revenue authorities so as to eradicate the common adulterant in Tinnevelly cotton locally known as *pulichai* (a variety of *G. neglectum*). The produce from the whole of the 1917 *pulichai* crop was bought by Government and the seed publicly burnt to prevent further propagation. Hilson, in an account of the "Northerns" cotton, grown in the Districts of Kurnool, Cuddapah and Anantapur, describes the methods of selection followed and the prevention of crossing by sewing up the unopened corollas several hours before they would open naturally. "The results obtained have not been very satisfactory. It has been possible to get three out of the four good qualities required combined in one plant but not all four. For example, No. 50 combines high yield, high ginning outturn and good class, but poor quality and

No. 14, high yield, good quality and good class but low ginning outturn." Roberts, in a recent paper, has dealt with the difficulties encountered in the introduction of American cotton in the Western Punjab. In Burma, McKerral reports that a strain of Wagale cotton (*G. neglectum* var. *rosea* sub-var. *arvensis*) with a ginning percentage of 40 per cent., against 31—33 in the unselected crop, has been sown on 1,000 acres. Various crosses on this type are being investigated. In the South Maratha country, Kottur has tested a strain of country cotton which yields 12 per cent. more *kapas* of a higher ginning percentage than the local variety. It is proposed to multiply and distribute seed of this type. Clouston reports that *roseum* cotton continues to spread on its merits in the cotton tract of the Central Provinces where it is replacing Berar *Jari*. An interesting development in this area is the spread, on account of high prices during the last two years, of the *rabi* cotton of the Chanda District, a type which appears to be the true *Bani* or Hinganghat. This year the crop is said to have amounted to about 10,000 bales.

Sugarcane.—A number of publications from the Cane Breeding Station at Coimbatore have appeared during the year. Barber has published two detailed papers on the tillering on the sugarcane and on methods of testing the suitability of sugarcane varieties of different localities by a system of measurements. A bulletin has also been edited by the same author dealing with the progress of the sugarcane industry in India during the years 1916 and 1917. This consists mainly of the notes submitted to the last meeting of the Board of Agriculture by the various Provincial Departments. Barber states that this information has not been given in sufficient detail particularly in the case of the United Provinces and Bihar. He considers that a case has been made out for the foundation of an Imperial Sugar Bureau whose "whole duty will be to collect and collate the results obtained in various directions and thus to be in a position to assist the isolated efforts in different parts of the country with sound advice, based on experience gained by a general survey of the work done in India now and in the past and that accomplished in other countries."

The testing, in Northern and Central India, of the first batch of sugarcane seedlings raised at Coimbatore is now in progress. A bulletin by Venkataraman dealing with the results obtained has been prepared for publication which will be dealt with in next year's report.

Indigo.—One of the difficulties encountered in the cultivation of Java indigo in Bihar is a condition known as wilt. After the middle of the monsoon, it often happens that the Java plant ceases to thrive, growth slows down, the foliage changes colour and afterwards becomes progressively reduced in amount. This is followed by the gradual death of the plant. Associated with the wilted condition during this period is extensive destruction of the fine roots and nodules. As there appeared to be a connection between the rise of the subsoil water in Bihar and the development of wilt, a

series of lysimeter experiments were carried out at Pusa in 1918 in order to determine whether or not there is any relation between waterlogging from below and the appearance of this trouble. The lysimeters consisted of cemented tanks, 1/1000 of an acre in area, built above the ground level and provided with drainage openings which could be closed or opened at will. Two series of three lysimeters were constructed. One set was filled with soil from the Kalianpur farm near Cawnpore, the other with light Pusa soil. The Kalianpur soil is exceedingly rich in available phosphate (0·318 per cent.) while Pusa soil, when analysed by Dyer's method, gives very low figures for available phosphate (0·001 per cent.). The results obtained were as follows :—

(1) In both Pusa and Kalianpur soil, the indigo in the lysimeters with free drainage escaped wilt.

(2) When the drainage openings were closed and waterlogging from below took place, all the plants were wilted in both Kalianpur and Pusa soil.

(3) The wilt in the Kalianpur soil (rich in available phosphate) was much more pronounced than in Pusa soil (said to be low in available phosphate).

(4) The growth in Kalianpur soil was much slower than in Pusa soil.

(5) The stoppage of drainage brought about an interesting change in the root system of the indigo and caused the laterals to run near the surface.

Plant breeding.—In the limitations imposed by the scope of an annual review, it is seldom possible to present an adequate idea of the Indian work which has been accomplished on the improvement of crops in recent years. Such a presentation is only possible if the work of a series of years is considered. This has been done in an article in *Nature* of July 25th, 1918, dealing with the proposed development in crop improvement in Great Britain. In this paper, India is quoted as affording a striking example of the successful application of new methods to plant production and a summary of the recent advances made in this country forms a large portion of the article.

A number of papers dealing with plant breeding questions have been written during the year. The Botanical Section of the Pusa Institute has prepared the first of a series of articles dealing with the pollination of Indian crops and also an account of the labour saving devices in plant breeding work adopted at Pusa. Anstead has contributed to the *Planters' Chronicle* a brief statement of the progress made in the establishment of new coffee hybrids which bear more heavily than the ordinary *arabica* and which are more disease resistant. McKerral has dealt with the variation and growth of the varieties

of *Sesamum indicum* cultivated in Burma. Warth and Ko Ko Gyi in the same Province find that the hydrogen cyanide content in Burma beans is a varietal character.

Rice.—A large amount of work is in progress on the rice crop, the principal centres being Dacca, Coimbatore, Insein and Raipur. Hector has extended the scope of his investigations in the Gangetic delta and is dealing with early (*aus*), transplanted winter and deep water paddies. It has been found that under the conditions obtaining at Dacca, cross fertilization takes place to an extent of about 2 per cent. per annum, an amount which is by no means negligible and which necessitates careful purification of the plots each year. Attention is being paid to the experimental error in variety trials of rice by Parnell and others. McKerral states that "the experimental error for various sizes and shapes of rice plots has been investigated. The results show that for varietal tests the most suitable method is to use long narrow plots (165′ × 6′) inside one large evenly worked and flooded embanked field. The strips are carried right across the field and separated from each other by a single line of a very late ripening variety with a conspicuous erect type of leaf with reddish colouration. The probable error of the single plots was found to be 5 per cent. and by using five plots of each variety tested, differences of 10 per cent. in yielding power can be detected." Hector writes that a convenient method of testing varieties has been established at Dacca by which the error is reduced to about 2·5 per cent. which is sufficient to establish with a good degree of certainty differences in yield of 7 per cent. and upwards. At Raipur, further selection work is in progress. The superiority of the *Luchai* rice, referred to in the last report, has been maintained and Clouston reports that it promises to be a valuble find for the rice tract. This type was discovered in the course of variety trials in a zamindari, 117 miles from the railway, where the cultivators maintained that the rices from the Government farms were not superior to their own *Luchai*. This proved to be the case. The incident is of interest in showing the desirability, in the case of an ancient cultivation like that of rice, of a fairly complete botanical survey of existing varieties before undertaking the distribution of seed.

There is one point in the rice investigations in India which is not brought out sufficiently strongly in the literature, namely, the distinctive field characters of the improved types now under distribution. This is of great importance in replacement work and in keeping the seed pure. New types, if possible, should possess some character by which they stand out clearly from the ordinary crop and by which they can be readily distinguished in the fields of the cultivators. If attention is not paid to this point, it is difficult to detect admixture and to check the district work in the systematic replacement of the country crop by an improved variety.

Fodder crops.—In connection with the development of the *bhata* soils of Chattisgarh, the provision of fodder is an important factor. Clouston reports that one of the small bamboos readily establishes itself on this soil and gives nearly 20 tons of green fodder to the acre which is much relished by cattle.

Jute.—Finlow writes that the work on the relation between the vigour of races of jute and the distribution of the root system is being continued. The types with surface rooting have been found to be more vigorous than those with a deep root system. These results confirm those previously obtained in the Botanical Area at Pusa in the case of various types of *patwa* (*Hibiscus cannabinus* L) and emphasize still further the importance of the soil aeration factor in all crops grown on the Gangetic alluvium.

BOTANY

II.—ECONOMIC BOTANY.

Part II.—Forest Botany.

BY

C. F. C. BEESON, M.A.,

Forest Zoologist, in charge of the office of Forest Botanist.

Oecology of Sal and Soil-aeration.—The results of a series of investigations carried out in recent years have, it is believed, solved the problem of regenerating sal. The factors injurious to the establishment of the seedling, due to the interaction of a soil-covering of dead leaves, drought and bad soil-aeration, are eliminated more effectively by a complete removal of the overhead canopy, rather than by burning the soil-covering, removal of undergrowth, with or without partial thinning of the overhead cover. Owing to the uncertainty of good seed-years and for other reasons, the restocking of the area by artificial sowings is preferable to reliance on natural regeneration. It has further been proved that much better results are obtained from broadcast sowings in cleared patches and narrow strips with full overhead light, than from sowings under the shade of a partial canopy.

The system proposed is a combination of the group and strip methods, in which the size of the unit regeneration areas is determined by the average height of the forest at maturity, and their sequence and orientation by local requirements for shade.

This method of regeneration is outlined in a paper by Mr. R. S. Hole, Forest Botanist in the *Indian Forester,* XLV, 1919, pages 119-132, and a detailed account of the experiments and conclusions has been submitted for publication as a *Forest Record.* It is applicable to the bulk of the sal forests of Central and Northern India, and it is claimed that it offers a good prospect of reducing the present regeneration period of these forests from 40 to 5 years.

2. Forest Grasses.—Experiments to determine the best method of cropping *ulla* (*Anthistiria gigantea*) for paper-pulp are being continued in the United Provinces. The results obtained to date from two years working are consistent and clearly indicate the best method of working.

3. Spike Disease of Sandal.—Investigations are in progresses in Madras and Coorg to determine the correlation between the incidence of the disease and the various factors that may be pre-disposing causes, *e.g.* the existence of lantana, occurrence of fires, transmission by insects, etc. Experiments have also been started at Dehra Dun on the connection between fungi and spike.

4. Mycology.—Work is in progress on the root-disease of sal, *Polyporus Shoreae,* the cause of "red-wood" in spruce and the root disease of sissoo (*Fomes lucidus*). In connection with the latter enquiry, control measures based on irrigation by percolation in place of irrigation by flooding, are being tested on an experimental scale in the sissoo and mulberry plantations at Changa Manga, Punjab.

5. Systematic.—Extensive collection of specimens by forest officers wa carried out mainly in connection with the preparation of local floras and descriptive lists. Four new species were described, *viz. Hopea canarensis,* Hole, *Ixora Butterwickii,* Hole, *Tamarix Troupii,* Hole and *Zizyphus hysudrica,* Hole. 240 specimens were identified for forest officers and others.

6. Publications.—During the year the following publications appeared :—

Hole, R. S. Spike disease of sandal, Ind. For., 1918, pages 461-462.
" " Notes from the Dehra Dun herbarium, Ind. For., 1918, pages 504-508.
" " A new species of *Hopea,* loc. cit., pages 575-576.
" " A new species of *Ixora*, Ind. For., 1919, pages 15-16.
" " The regeneration of sal (*Shorea robusta*) forests, loc. cit., pages 119-132.
" " Cause of spike disease in sandal, loc. cit., pages 133-139.
" " A new species of *Tamarix,* loc. cit., pages 247-249.

and the following papers by the same author are in the press as Indian Forest Records :—1. *Note on Hopea canarensis,* Hole, 2. *Note on Ixora Butterwickii,* Hole, and 3. *Note on the Regeneration of Sal Forests.*

BOTANY.

II.—ECONOMIC BOTANY.

III.—Mycology.

BY

E. J. BUTLER, M.B., F.L.S.,

Imperial Mycologist.

Agricultural Research Institute, Pusa.

The following is an account of the chief investigations at Pusa during the year :—

Ufra of Rice.—An account of the investigations on the rice worm (*Tylenchus angustus* Butl.) carried out during the past few years by the writer, together with the field experiments and demonstrations in its control in which the officers of the Bengal Department of Agriculture collaborated, was published. Most of the results described have been referred to in previous reports.

Black band disease of Jute.—Dr. Shaw continued research work on this disease and carried out a series of field experiments directed to determine its mode of transmission. The attack in Bihar was less than in the previous year, probably because the dryness of the season in September led to a rapid ripening of the crop, which was mostly harvested a month earlier than in 1917. This did not give the parasite enough time to multiply seriously. Evidence was obtained that only stems of a certain size and maturity are susceptible under Pusa conditions and naturally this, if generally true, relieves much of the anxiety felt in regard to the attack on plants intended to be cut for fibre. On these it would be capable of causing great damage, as it possesses a cellulose-dissolving enzyme and will grow on pure cellulose in a solution of inorganic salts. But hitherto the bulk of the damage has been found on plants kept for seed. The examination of the fibre crop in several districts in Eastern Bengal in August and September, 1918, supported these results and also led to the observation that red-stemmed *Corchorus capsularis* grown at Dacca was only slightly attacked, while *C. olitorius* appeared to be immune. Artificial inoculations now in progress do not, however, suggest that the red-stemmed forms always escape. Temperature and humidity are probably controlling factors in determining the success or failure of inoculations on ordinary varieties.

The field experiments suffered considerably from the short monsoon of 1918 but suggested that the spread of the disease through spores adhering to the seed was not an important means of dissemination. If this is confirmed it may allow a relaxation of the seed disinfection measures at present adopted and which were applied last year at Pusa to the whole Bihar crop of the new selected varieties, amounting to some 40 tons of seed.

Sclerotial disease of Jute.—An interesting development took place during these investigations of jute diseases in the knowledge obtained regarding the sterile fungus referred to in previous reports as *Rhizoctonia Solani* Kühn. Dr. Shaw has discovered a spore stage which so far has only appeared on the infected living jute plant but which in artificial culture reverts to the sterile sclerotial condition indistinguishable from the form identified previously as *Rhizoctonia Solani*. Inoculations with the latter have regularly given the sporing stage. This appears to agree with a recently described Formosan jute parasite, *Macrophoma Corchori* Sawada. If confirmed an important step in advance will have been taken in the study of the Indian *Rhizoctonias,* of which the present is one of the most puzzling species.

Diseases of temperate fruits.—Work on these was continued by Dr. Shaw in Kumaon and Peshawar. In the latter district a successful method of controlling the destructive peach leaf curl has been worked out in collaboration with Mr. Robertson Brown and the current year's tests have continued to give most satisfactory results.

In Kumaon apple diseases are at present the most important and much work has been done on them. A large series of spraying experiments was carried out with varying success. Apple mildew is perhaps the most widespread of these diseases and some encouraging results have been obtained with strong lime-sulphur and with a mixture containing iron sulphide. Fly speck and sooty blotch (*Leptothyrium Pomi*) were reduced by lime sulphur. The disease caused by the fungus provisionally identified as *Coniothecium chromatosporum* is less readily controlled. Further work is projected.

Chilli diseases.—Work on these was continued by Mr. Dastur but was much interfered with by the dry weather which prevailed during the normal period of attack. There was so little disease that the field experiments gave scant results and they are being again repeated.

Pythium disease of Ginger.—The fungus causing the soft rot of ginger, damping off of tobacco seedlings and foot rot of papaya is fully described in a memoir by Mr. Subramanium now in the press. It is regarded as a new species, and is of interest owing to the variety of plants which it is capable of attacking. Potato, castor and chilli are amongst these.

Pigeon pea wilt.—A study of the cause of the remarkable differences in the severity of this disease in certain of the plots of the permanent manurial experiments at Pusa has been commenced by Mr. Finlow, Fibre Expert to

the Government of Bengal, and the writer. For several years past it has been noticed that there is very much more disease in the plots that have received mineral fertilisers than in those that have had no manure. As the plots are under very complete control and have been uniformly treated for the past eleven years they are unusually suitable for an investigation of this nature. Either the treatment of the plots has in some way altered the composition or characters of the host plant, or it has influenced the parasite, *Fusarium udum* Butl., a soil-inhabiting species. If the former, it should be possible to correct the deleterious action of the minerals by appropriate manuring, since the phenomenon is probably, in that case, nutritional. If the latter, it should be capable of detection by regarding the soil as a nutrient medium for the parasite. A new series of permanent experiments has been laid down to test the former of these views, while the latter is being attacked in pot cultures and by laboratory methods. It is hoped that the investigation will throw some light on the obscure problems of immunity and susceptibility to disease in plants.

Sugarcane smut.—Mr. Dastur has discovered the method of infection made use of by the fungus (*Ustilago Sacchari* Rabenh.) which causes this destructive disease. It is one that appears to be quite unique amongst the smuts hitherto investigated from this point of view. Entry into the plant takes place through the hairs on the young shoot-bud scales. Older buds can only be infected if wounded or injured. He has failed to secure infection through any other part tried.

Rangoon Bean blight.—Work on this disease was continued by Dr. Shaw, who visited Burma for the purpose. The responsible fungus is allied to *Sclerotinia*, and is quite distinct from *Phytophthora Phaseoli* Thaxt., which attacks *Phaseolus lunatus* in other countries. The severe outbreak in 1918 is attributed chiefly to improper methods of cultivation, and the improvement of these on the lines recommended by Dr. Shaw and the Burma Department of Agriculture will probably be effective in controlling the disease.

Miscellaneous.—Experiments in the checking of the rot of stored potatoes have been undertaken in the Punjab. The losses from this source, especially to seed potatoes, are very serious in many parts of India.

Dr. Shaw has continued his work on sclerotial fungi and on *Orobanche* of tobacco and mustard. *Nicotiana rustica* is not attacked by the latter at Peshawar, but the crop from Peshawar seed grown at Pusa was just as badly diseased as the local varieties.

A comparative study of the species of *Helminthosporium* on cereals has been commenced, while that of some *Phytophthoras* was continued. The latter work has strengthened the view that all the forms hitherto found on rubber in India and Burma are identical, but there is still some doubt about the Malayan species. Specimens of a *Phytophthora* which causes bud rot of coconuts in Jamaica were found to be identical with the writer's

Ph. palmivora, and this will probably lead to a re-investigation of the disease in other countries where it is at present almost universally believed to be bacterial.

Other Scientific Departments.

The following are the chief items of mycological work in other scientific departments, usually Departments of Agriculture :—

Madras.—Mr. McRae has published his work on *Phytophthora Meadii* n. sp., the cause of the destructive leaf-fall, fruit-rot and bark-rot of *Hevea* rubber. This important contribution to the knowledge of rubber diseases is based on work extending over several years and in part referred to in previous reports. The paper itself must be consulted for further details.

Another rubber disease has come into prominence and threatens to cause serious loss. From the description there is little doubt that this is the notorious "Brown bast" disease which has developed with such rapidity throughout practically all rubber-growing countries in the East and which is now occupying the attention of rubber mycologists almost to the exclusion of everything else. Its cause is still a mystery. Mr. McRae has carried out detailed histological observations on its effects.

The bud rot of the palmyra palm still continues in the Godavari and Kistna districts. A general examination of the palms was again carried out between December and March and the number of cases recorded. The diseased palms are treated by excision of infected parts. The total has fallen from 77,000 to 44,000 in the last five years, but the decline has been slow since 1917. The application of the recently passed Madras Pest Act will throw the onus of dealing with the disease on the owners of trees. At present they only do so when the Revenue Inspector visits the village. If this results in treatment as soon as symptoms appear, a greater number will be saved and the possibility of infecting healthy trees reduced.

The fungus *Thielaviopsis ethaceticus* Went from coconut palms affected with the stem bleeding disease has been under study. Inoculations on unwounded young palms failed, but when the fungus was inserted into a shallow hole in the stem it caused death. Older palms were successfully inoculated through wounds in only one case out of eleven tried. Treatment by cutting out the infected tissue and flaming and tarring the wound has given very good results; so far only three out of a hundred thus treated have shown a recurrence of the disease.

Blast of paddy, caused by *Piricularia Oryzæ* Br. & Cav., was wholly absent from Tanjore where it was epidemic last year. Slight damage was caused at Coimbatore. The parasite, or a closely allied species, was found causing an epidemic on *Panicum repens*, a common grass on paddy bunds. Wheat and barley have been successfully inoculated with the fungus from rice. At the Coimbatore Paddy Breeding Station the heavy yielding varieties

and individual plants are susceptible and the disease may prove a limiting factor in the production of heavy yielders.

Spraying of grape vines in the Salem district was repeated, oidium being treated in the dry season and anthracnose in the wet. In both cases the difference in favour of the sprayed plots was marked and about 30 per cent. more bunches were marketable from them than from the unsprayed plots.

Work on *Vermicularia Capsici* Syd. was continued and its range of natural host plants extended amongst the weeds of chilli field. There is little doubt that the fungus is carried over from crop to crop of chillies on these weeds.

Further experiments on treating the smut (*Ustilago Crameri* Körn.) of Italian millet (*Setaria italica*) confirmed the efficacy of steeping the seed in a 5 per cent. solution of copper sulphate.

Mr. Anstead, Deputy Director of Agriculture for Planting Districts, has co-operated with Mr. McRae in field work on diseases of rubber and tea. The experimental areas for treatment of *Phytophthora Meadii* McRae on rubber have been continued, but the light monsoon reduced the amount of disease. Removal of the fruit before the middle of June diminishes the disease, but labour is a difficulty. Cutting out all dead and dying branches in the dry weather, combined with pruning all those that hang down, has had a marked effect on an estate of 300 acres and is a more practical proposition. With pink disease (*Corticium salmonicolor*) experiments on a small scale in the use of Bordeaux mixture gave encouraging results and will be extended. Field work on "brown bast" is also in hand.

In tea, grey and brown blights are still prevalent, but can be effectively controlled.

Mr. Anstead is getting highly satisfactory results in the spraying of coffee against leaf disease (*Hemileia*) and black rot (*Corticium Koleroga*). Where water and labour are satisfactory the treatment undoubtedly pays.

Mysore.—In this State the Agricultural Department is carrying out research work on the spike disease of sandal, black rot of coffee and the root disease of the areca palm caused by *Fomes lucidus*. Field experiments to secure potatoes free from the ring disease have been continued. The campaign against Koleroga (*Phytophthora Arecæ*) is resulting in stamping out the disease in certain areas; at the same time attempts are being made to obtain a variety of the palm resistant to the disease.

Bombay.—The mycological staff in this Province consists of Mr. Ajrekar, who has also been acting as Economic Botanist, and Mr. Kulkarni. They have given much time to the study of potato diseases, especially the rots of stored tubers. The fungi causing dry rot (*Fusarium*) and black rot (*Rhizoctonia*) have been isolated and successful inoculations secured. Besides these, another form of injury, called black heart, is found, but is a heat effect and not a parasitic disease. Black rot is usually followed by the wet bacterial rot which completes the destruction of the tuber. Temperature seems to regulate

the ravages of this rot, temperatures above 30° C. favouring it while below 30° C. it develops but slightly. Powdery scab (*Spongospora*) is found in hill districts not only in Bombay, but also in Madras and Northern India, but so far has not been found in the plains.

Field experiments with red rot of sugarcane and smut of sorghum were continued, and the spraying work against Koleroga of areca nut was extended.

Amongst the other diseases studied were a new smut of ragi (*Eleusine coracana*), a withertip disease of onions and the mildews of chilli, mango and cumin. The mango mildew was found to be much more common on the inflorescence than previously suspected. Experiments in treating cumin mildew indicate the possibility of control by Bordeaux mixture sprayed on the crop when about a month and a half old.

The investigation of the *Sphacelia* and *Cerebella* on sorghum ears has established that these are distinct fungi and not stages in the life of a single species as at first suspected.

Bengal.—Work in this Province was practically restricted to the experimental treatment of diseases of mango, pine-apple, sugarcane, jute, mulberry and rice, carried out by Babu A. L. Som, Mycological Collector, Bengal Department of Agriculture.

Central Provinces.—Attempts to check cotton wilt by heating the soil and by a dressing of common salt gave no definite result nor did the treatment of infected soils with copper sulphate, sulphuric acid or superphosphate. A dry heat of 65° C. was found to be effective, but it is difficult to see how this can be applied in practice.

Indian Tea Association.—Mr. Tunstall, Mycologist to the Indian Tea Association, continued his investigations of tea diseases. A pamphlet on the disease caused by *Nectria cinnabarina* was published during the year. The branches die off slowly and the whole crown may wither, but a healthy new growth develops after collar pruning. The fungus was found commonly on fallen fruit stalks of *Pyrularia edulis* and *Alnus nepalensis* from which it is carried to the tea. Treatment with a lime-sulphur spray was quite effective.

Experiments were carried out to test the longevity of various fungi parasitic on tea. The common leaf parasites were found to survive throughout the cold weather if not exposed to the sun, but none survived exposure to the sun for four months.

A study of species of *Exobasidium* in the high-level Himalayan forests was commenced, eight species of plants being found to carry these fungi. Mr. Tunstall is inclined to believe that blister blight of tea (*Exobasidium vexans*) reached Darjeeling district through the higher ranges of the Himalaya.

AGRICULTURAL BACTERIOLOGY.

BY

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Imperial Agricultural Bacteriologist.

WORK AT PUSA.

Soil Bacteriology.

Nitrification.—Field and plot observations of seasonal variation in nitrification in soils under crop and fallow were maintained; the results obtained confirmed the opinion that movement of soil water either upward or downward conduces to increased formation of nitrates; such movement may be caused by drainage, by surface evaporation, or by plant absorption (transpiration), this last factor accounting for the greater total nitrification found in cropped as compared with fallow plots. An important point affected by soil management seems to be the annual re-establishment of nitrifying flora to take the place of that eliminated by adverse conditions, such as waterlogging, during the monsoon; the success of this operation depends upon recognition of the fact that nitrifying bacteria can perform their specific function under conditions adverse to their multiplication; such conditions include not only the presence of specific toxins but of excess of organic matter or of ammonia; the immediate oxygen requirements of the nitrifiers are generally satisfied in almost any soil but waterlogging during the monsoon not only conduces to the development of toxin producing bacteria but to the bringing into solution of excessive amounts of organic matter all of which tend to depress the nitrifying flora as an indirect effect of anœrobic conditions. The addition of inert material of large superficial area such as broken brick or clinker appears to provide a suitable nidus for the development of nitrifying bacteria, not so much in the soil as on the surface of the broken material, thus setting up conditions similar to that in a sewage filter, where solutions containing concentrations of organic matter too high to allow of development of nitrifying flora are nevertheless nitrified by the organisms previously established on the broken surfaces. It is of interest to note that in experiments dealing with the addition of broken brick and potsherds to soil it is necessary to make allowance for the frequently high content of nitrate, generally as saltpetre, found in such materials in Bihar.

A considerable amount of work was done by the First Assistant on the different rates of nitrification of various organic materials in soil. These

included various green manures and other plants, and oilcakes and it was found that the non-nitrogenous portion had an inhibiting action upon the nitrification of the nitrogenous fractions. A paper on this subject was read by the First Assistant at the Indian Science Congress, Bombay (January 1919).

Further experiments on the inhibition of nitrification by toxins resulting from anœrobic incubation of soils were carried out; it was found that nitrification did not begin for ten weeks in Omelianski solution made up with water extract of anœrobically incubated soil, whereas nitrification was complete in eight weeks in a similar solution but from an ærobically incubated soil. Similar results were obtained when using pure cultures of nitrite formers seeded into these media.

The effect of excessive quantities of nitrogenous matter in inhibiting nitrification was tested in various soils; in Pusa soil 60 mgms. N. per 100 gms. soil was found to be the maximum amount allowing complete and normal nitrification, either as Ammonium Sulphate or oilcake; when applied as a mixture of these two, however, it is possible to raise the combined amount to 90 mgms. without prejudicing the nitrification either by loss of ammonia or by delay. It is of interest to note that nitrification can take place even in a soil in which there is sufficient free ammonia to be detected by smell and litmus reaction.

Green Manuring.—The green manuring experiments carried out in collaboration with the Imperial Agriculturist on the Punjab experimental plots were continued. These experiments begin to show the valuable residual effect of such treatment on Pusa soils especially with fermented green manure (*Crotalaria juncea*). Incidentally most valuable and interesting light has been thrown upon the interpretation of the results of field experiments on such soils and in such a climate; the results obtained show clearly first of all the necessity of previously ascertaining the relative fertility of the plots before treatment and the absolute worthlessness of most manurial experiments without this precaution, and secondly the equal necessity of taking into account the effect of seasonal variation from one year to another. These points as illustrated by the green manuring experiments referred to, are discussed in an article on this subject in the Indian Journal of Agriculture now in hand.

Biological Analysis of soils.—Further work was done on this subject and the question of the use of a standardized method was discussed at the Conference of Agricultural Chemists and Bacteriologists at Pusa in February. A special study was made of certain infertile soils (Manat) from the Konkan division (Bombay). The First Assistant visited this district and inspected the soils in the field and having carried out biological analyses in the laboratory a report with recommendations for treatment was written and submitted to the Director of Agriculture, Bombay.

Nitrogen fixation.—The question of the nitrogen supply in Indian soils and exhaustion by the introduction of intensive cultivation and heavy yielding varieties of crops was dealt with in a paper by me read at the Indian Science Congress in Bombay. In this paper attention was drawn to the danger of encouraging methods of exhausting Indian soils without making any adequate provision for keeping up the supply of the ingredients removed by increased crop yields; the loss of nitrogen especially must be guarded against when this takes place at a rate exceeding that of the natural fixation by legumes and non-symbiotic soil organisms. In this connection it was pointed out at the Conference of Chemists and Bacteriologists at Pusa in February 1919 that special attention should be paid to the study of the conditions under which nitrogen fixation takes place in Indian soils, with a view to determining the possibility or otherwise of artificially obtaining optimum conditions for such fixation as a practical field measure. The very great variations in the amount of nitrogen fixed in the same soil in different years show clearly the possibility of influencing fixation by soil management without the necessity of adding impossibly expensive materials (such as sugar) to the soil. In the Punjab, nitrogen to the extent of 30 per cent. of that already present in a soil under single crop wheat, was fixed in less than six months in one season, whereas during the following one the amount was negligible. The possible symbiotic relationship between green algæ and nitrogen fixing organisms in soils formed a subject for investigation at Pusa by the Supernumerary Bacteriologist before the war as a continuation of his study of Azotobacter in India and has now been resumed on his return from military service.

Further work on fixation of nitrogen by legumes was carried out and a memoir embodying the results was written by the First Assistant. It was found that in cases where nodule formation did not occur owing to the use of strains of the radicicola organisms foreign to the plant, the latter nevertheless benefitted by the supply of nitrogen asymbiotically fixed in the soil to which such organisms had been added artificially. Similar results were obtained with Azotobacter inoculation and by the growth of legume bacteria in artificial media separated from the soil containing the growing plant by porous cylinders. An interesting and important point was noticed, namely, that in the case of *B. radicicola* no residual nitrogen was found in the culture sand suggesting that fixation of nitrogen proceeded *pari passu* with its removal by the growing plant, whereas with Azotobacter this was not the case. A modified medium (soil extract, mannite, asparagin agar) was found to allow ready isolation of the organisms direct from soil.

Indigo.

The isolation of considerable quantities of pure Indican in the laboratory of the Indigo Research Chemist permitted the use of synthetic media for the cultivation of the various strains of indican hydrolyzing bacteria already

isolated in the bacteriological section during two previous seasons on agar made up with indigo leaf extract. It was found that very little growth or hydrolysis took place in media in which indican was the only source of nitrogen, whereas the addition of small quantities of leaf extract activated this at once. Study of the physiological aspects of this question is being carried on.

Manufacture.—Further experiments were carried out in the experimental factory on the hot water extraction method. Very good results were obtained by the use of lime precipitation following extraction and preceding inoculation with hydrolyzing bacteria; the improvement not only included higher percentage extraction of the indican present in the plant, but greater purity in the product. Experiments were initiated in the use of hypochlorite sterilization of the water and plant as an alternative to hot water extraction; this would be a very much cheaper method of eliminating undesirable bacterial flora than the use of hot water, but it is not yet clear whether it will be possible to obtain the high percentage extraction of indican given by the latter process.

A point of great practical interest arose during the first days of manufacture. It was found that owing to the "weathering" of the cement lining surfaces of the vats during the months intervening between one manufacturing season and the next following one, lime was set free by disintegration in sufficient quantity to produce an alkaline reaction in the steeping water of such a degree as to interfere seriously with the growth and activity of the hydrolyzing bacteria; in this way fermentation was delayed to such an extent that even after twelve hours this process then normally complete was only just beginning. It was found necessary to add considerable quantities of acid (250 cc. of 50 per cent. Sulphuric acid per 600 gallons) to neutralize this alkalinity. There can be no doubt that a similar action takes place in all factories using cement walled vats, and that the "warming up" of the vats commonly noticed at the beginning of each season is due partly to the removal of the disintegrated lime from the walls as well as to the gradual establishment of the necessary bacterial flora.

It is of interest to note here that numerous reports have been received from indigo factories of improved yields resulting from the use of cross walls or other methods of increasing the wall area of the vats, recommended (1917-18) as a result of the discovery of the importance of bacterial action in the fermentation of the indigo plant.

Pebrine.

Further study of the problem of elimination of this disease of the silkworm in India, included trial of the effect of hill rearing upon the natural resistance of the larva to infection. Experiments were carried out at Shillong during August and September; layings of eggs from Pusa were divided, half being

reared at Pusa and half at Shillong; artificial infection was carried out at both places and it was found that even in the first generation a considerable increase in the resistance to infection was obtained in the hill reared larvæ. Eggs from the latter were transferred to Pusa both from infected and from disease-free moths, and further resistance to infection in the plains was noted in the latter, whilst in the former a smaller percentage of infected larvæ resulted from the hacthing out of seed from the diseased moths; the infected larvæ also survived through a greater number of moults and a larger percentage of them attained maturity than is usual in such cases. It was also noted that the hill reared worms produced better cocoons. It is proposed to continue this line of experiment and to recommend the institution of a central seed station at Shillong to provide ameliorated seed for the Indian industry. The revised method of examination of moths previously reported has been adopted by various grainages in India; the Sericultural Superintendent at Berhampore (Bengal) has reported favourably on his experience of its use during the last season. It is abundantly clear that owing to the use of multivoltine races in India and the generally insanitary conditions under which rearing is carried out it is essential for the rearer to begin his season with disease-free seed, in default of which the rapid cumulative effect of any small percentage of disease initially present, in the course of rearing the numerous broods characteristic of the multivoltine races, will inevitably result in the failure of a fatally large proportion of the worms. For this reason it is necessary to adopt in India a much higher standard of purity in the seed issued by grainages than is customary in Europe. A lecture on this subject was given at the Entomological Conference held at Pusa in February 1919. A memoir on the mechanism of infection and the elimination of pebrine in India is now in the press.

Sterilization of water.

Attention was drawn to this subject owing to the outbreak of a severe cholera epidemic in the neighbourhood of Pusa, and the difficulty of obtaining antiseptics. Attempts were made to obtain a stable hypochlorite solution by electrolytic methods and the work was transferred to Shillong whilst I was on hill recess there; owing to the kindness of the Director of the Pasteur Institute who allowed me to work in his laboratory and the courtesy of the officers of the local Government who allowed me to make use of the electric current supply of Government House, I was able to continue this investigation and was also fortunate enough to secure the assistance of Captain W. Hodgkinson, R.E., who was put on deputation by the Army Department for this purpose and has since been working on this problem at Pusa. It has been found possible to produce a solution containing from 3-4 per cent. available chlorine by electrolysis from purely Indian raw materials, thus avoiding the use of imported bleaching powder and having the consequent advantange of avoiding the great loss of chlorine in transit and in store incidental to the use of "bleach;" at the same time this solution (now known as E. C.) can

be prepared anywhere where electric current is available, and can be made of standard strength merely by reading figures on an ordinary current meter without expert knowledge either of chemical or electrical methods. This work was done at the instance of the Stores Department of the Indian Medical Service with the object of providing a reliable method of sterilizing water for troops on field service or elsewhere; the principal difficulty encountered has been to obtain a sufficient degree of stability to allow of storage for such periods of time as may be necessary for transport to situations where electric current is unavailable; the degree of stability possessed by E. C., like that of all hypochlorite solutions, varies inversely with the temperature of storage, but owing to the method of preparation and the use of an appropriate stabilizer it should be sufficient to ensure its efficiency under most conditions likely to be encountered. Further work is now being done to ascertain the most efficient form of apparatus for production of this solution on a practical scale.

Work in the Provinces.

Central Province.—Biological studies of embanked wheat soils were carried out, and definite relationships demonstrated between bacterial activities and crop yields. Management of the water supply was shown to be of primary importance combined with avoidance of stagnant conditions leading to reduced nitrification.

Tests of relative rates of nitrification of various organic manures in black cotton soil, were carried out and the results published in the form of an article in the Agricultural Journal of India, November 1919.

Punjab.—Work on nitrogen fixation in various soils was carried out; the results to date are not yet available.

FORESTRY.

I.—SILVICULTURE.

BY

W. F. PERREÉ, C.I.E.,

Officer-in-charge, Silviculturists Office.

Statistical work in typical forest crops.—The work of establishing permanent and temporary sample plots in typical forest crops, with the object of obtaining statistics relating to volume production, could only be continued this year in the Thano forests of the United Provinces on account of the absence on leave of the Silviculturist. During the year 6 existing permanent sample plots were remeasured and 2 new ones were established. The quinquennial remeasurements of sample plots commenced in 1915-16 and data are being collected in order to make the publication on the subject of appreciable interest. The total number of sample plots established to date is 286.

The sal tree (Shorea robusta).—The eight strips laid out in 1916-17 in Thano forests with the object of inducing natural reproduction were under observation during the year, but definite results are not likely to be attained for some time.

Two sample plots have been laid out during the year in Thano forests with a view to ascertaining the effect of severe thinning (*a*) at an early age and (*b*) at maturity.

Mr. Marsden, Silviculturist, after remeasuring 61 sal sample plots which were established in the United Provinces in crops of uniform development, has in his article "The Girth-increment of sal in regular Crops in the United Provinces," published in the *Indian Forester*, attempted to show graphically the rate at which the girth of sal increases in even-aged forests.

The question of the dying back of sal seedlings is receiving more attention and Mr. Smythies has in a note published in the *Indian Forester*, given results of a single experiment conducted by him. His conclusions, which require further observations, bring out some interesting results, *viz.* :—

(1) that under heavy shade, sal seedlings continue to die back very regularly all through the cold weather and hot weather. In this experiment more than 75 per cent. died back.

(2) that a heavy clearance and removal of shade causes those seedlings, which are going to die back, to do so *immediately*. In this case, to the extent of 85 per cent.

(3) that at the beginning of the hot weather many of the seedlings which have died back in the felled area shoot up again and persist through the hot weather. (It should be noted that weather conditions were very favourable, with excellent rain in April and again in May.)

It is as yet impossible to draw conclusions from this experiment.

An inspection of the experiment to test the effect of clear felling in one operation in Thano forests, reveals that there is little advantage in having two regeneration fellings where natural reproduction is already present in sufficient quantity. Besides causing almost unnecessary waste of time and energy it does much damage to the young crop in the second fellings. One of the main reasons for the retention of a part of the overwood is to protect the young crop from frost, but its effectiveness in case of severe frost, is doubtful. It has been found out that overhead cover which is sufficient to protect from damage by frost is also sufficient to suppress young sal and that side protection is of greater value than overhead protection. In Thano forests where the risk of ordinary frost damage is slight a clear felling in one operation followed, as usual, by cleaning and cutting back, will, it is hoped, prove its worth as a means of regenerating the area. To substantiate this idea, an area of 5 acres has been marked during the year for clear felling in Compartment 8 and the result is being watched.

Tan-yielding trees.—*Anogeissus latifolia.*—Additional experiments are being carried out in order to find out the best season for pollarding.

Cassia auriculata.—Further experiments are in hand to stimulate its germination. Various methods of transplanting it in different seasons are also being tried. This species is also under study in Burma.

Phyllanthus Emblica.—Direct sowings and transplants from nursery have both proved successful. Germination was from 70 to 90 per cent. This species has been found to stand frost.

Elaeodendron glaucum.—Experiments carried out with this species show 70 per cent. germination. Both direct sowings and transplanting are so far successful. Frost also does not affect this species.

Afforestation.—The work of afforestation in Zaberkhet Tapper, a grassy blank subject to heavy frost, was continued. The following inferences are deduced :—

1. *Dalbergia Sissoo* and *Melia Azedarach* are the most promising species ; next to these are *Cassia Fistula, Terminalia tomentosa, Acacia Catechu* and *Mallotus philippinensis.*

2. *Dalbergia Sissoo* is damaged less than other species by deer.

3. Weeding is very essential : almost all the unweeded beds of *Dalbergia Sissoo*, *Acacia Catechu* and *Melia Azedarach* have failed, but in the case of *Cassia Fistula* it is not imperative.

4. Rooted cuttings of *Dalbergia Sissoo*, *Bombax malabaricum*, *Eugenia Jambolana*, *Grewia vestita* have been successful. *Terminalia tomentosa*, *Ougenia dalbergioides* and *Mallotus philippinensis* have given fair results.

5. *Chir* (*Pinus longifolia*) can better be raised from direct sowings than by transplanting, the month of July is the best season for transplanting this species.

6. Nearly all species suffered alike from defective rainfall.

The Silvicultural Garden.—Experiments are in progress for testing the germination, growth and development of important species under nursery treatment as well as in raising pure crops. Various methods of direct sowing and transplanting during different seasons are under trial.

Experiments were continued in the cultivation of *Cinnamomum Camphora*, as a bush in the same way as tea, with a view to ascertaining the yield of camphor at different seasons.

Developments in Silvicultural systems.—Much attention has been paid to the collection of statistics in connection with the rate of growth of crops and to suggesting and framing experiments in new methods of reproduction, natural and artificial, with a view to their adoption for regenerating a crop.

Several experimental plots laid out for the observation of the effect upon natural reproduction of overhead shelter in conjunction with hoeing, burning, etc., are under study.

The following is the work done by the Forest Research Officer, Burma :—

1. *Uniform System.*—Much progress was made with experimental work in the regeneration of teak and other valuable species under this system in the Tharrawaddy, North Toungoo, Pyinmana, Ruby Mines, Katha, Mansi, Myitkyina, and Bhamo divisions.

2. *Gap Fellings.*—Gaps were cut in the heavy forests of *Bambusa polymorpha* in several parts of the Pegu Yoma, and the results of the ensuing teak generation were recorded. They were not very satisfactory.

3. *Coppice.*—The coppicing power of various trees were recorded.

Mr. Collier's working plan for the Haldwani Forests Division prescribes selection and improvement fellings for the hill forests of the division as definite means for affording protection to the soil. He is of opinion that the introduction of the uniform system will tend to increase the possibility of damage from fire and draught. For the *Bhaber* Sal forests of the division a modified group system is prescribed as a system especially adapted for the ntroduction of a more regular gradation of age classes into selection worked

forests. The merit of this plan is in its elasticity. The working-plan officer fixes a volume possibility after selecting the first periodic block. The Divisional Forest Officer is not tied down to any fixed method of felling and the heaviness and general conduct of the fellings are regulated according to the conditions of the regeneration in the several compartments and blocks. Mr. R. S. Troup in his " Note on some European Silvicultural Systems, with suggestions for improvements in Indian Forest Management " has discussed the portion of this working-plan relating to the *Bhaber* Sal forests.

The Naini Tal Division working-plan of 1916 brings into operation the latest information and methods for the valuable *chir* forests of the outer ranges. Statistics collected by the Silvicultural Branch were made use of in determining the length of rotation. The addition of illustrations serves to make the working-plan report more interesting.

Other working-plans published during the year present no novel feature in the methods of management and call for no special comment.

FORESTRY.

II.—ECONOMIC FOREST PRODUCTS.

BY

R. S. PEARSON, I.F.S., F.L.S.,

Forest Economist.

Observation and encouragement of the paper pulp industry in India and Burma.—*Bamboo pulp.*—Areas were inspected in the Chittagong Hill Tracts and in the Hoshangabad Division in the Central Provinces by the undersigned to ascertain their suitability for the extraction of Bamboo for paper pulp, while Mr. Raitt examined certain areas in Cochin, Travancore, Arakan and Tenasserim with the same object. Some of these areas proved eminently suitable for the purpose.

The result of the enquiry into the possibility of making paper pulp from bamboos, which has now been in progress for about ten years, has resulted in the erection of one factory and the granting of leases to three firms, two of which have placed orders for plant, while several other applications are being considered.

Antiseptic treatment of timber.—The experimental pressure Creosoting plant is now on its way from England and a supply of Silver Fir and Spruce sleepers has been seasoned and stored ready for treatment at the Research Institute.

The outcome of the experiments carried out during the last ten years, is the acceptance, on the part of Railway Engineers in India, of the project of utilising treated sleepers of certain species of timber and the North-Western Railway have placed orders for a Creosoting plant to turn out a large number of creosoted Silver Fir and Spruce sleepers. The Assam-Bengal Railway have a similar scheme in hand to treat *Dipterocarpus pilosus* sleepers.

Physical and mechanical Properties and seasoning powers of various timbers.—(i) Natural Seasoning.—As a result of the conclusive data obtained from the first series of experiments, a very much more comprehensive scheme for further similar experiments was drawn up. These experiments have now been started and embrace a total of about 76 species, the logs pertaining to which have now been laid down at various centres in the Punjab, United Provinces, Assam, Bengal, Bihar and Orissa, the Central Provinces and Madras.

Notes on the methods of natural seasoning adopted at the Gun-Carriage Factory, Jubbulpore, and at various Sawmills in the south of India were collected during the course of the season's tour.

(ii) Artificial Seasoning.—As a result of information collected on this subject, steps are being taken to obtain the standard American and English designs of Drying Kilns, *viz.*, the Tiemann and Sturtevant Kilns, which it is proposed to set up at Dehra Dun with the object of ascertaining the relative merits of these plants and the feasibility of adopting a standard pattern of drying plant to suit Indian climatic conditions.

(iii) Mechanical Properties of timber.—At the suggestion of the Munitions Board, a series of tests were undertaken on a number of possible Aeroplane timbers, with the primary object of discovering an Indian substitute for Ash and Spruce. Up to date 29 species have been tested for elasticity, transverse strength, compression, shearing and hardness and the results so far obtained indicate that the white wood of White Chuglam (*Terminalia bialata*), an Andaman timber, may be expected to prove a suitable substitute for ash and *Pterocarpus dalbergioides* (Andaman Padouk) for propeller blades. Poon (*Calophyllum tomentosum*) of the West Coast and *Shorea assamica*, though showing promise at first, on more exhaustive tests being carried out, were found to be unsuitable as a substitute for Spruce.

(iv) Strength of Sal timber.—A number of tests were carried out on Sal timber, grown under various conditions, in connection with the detailed enquiry which has been undertaken with the object of determining the relative strength of plains and hill grown, seedling and coppice grown Sal. The series of tests have now been completed and the results of the enquiry will shortly be published.

(v) Glue and Cement tests.—At the request of the Air Board, the question of carrying out tests on the various Glues and Cassein Cements, proposed for use in Aircraft Manufacture, was taken up. After evolving a standard pattern for the test pieces to suit the timber testing machine, a series of tests were carried out on various kinds of glues and cements and the results have been submitted to the Air Board. This enquiry is still in progress.

Finding of markets and new uses for timbers, including the issue of Bulletins.—The collection of information regarding six species, *viz.*, *Bombax malabaricum*, *Adina cordifolia*, *Odina Wodier*, *Lagerstroemia Flos-Reginae*, *Dipterocarpus pilosus* and *Hopea odorata* was completed during the year and Bulletins on these species are being written up and will be shortly ready for publication.

Gums, resins and oleo-resins.—The publication of the results of the enquiry regarding *Boswellia serrata* Gum Oleo-resin has elicited a number of enquiries on the subject. Tapping operations are now being undertaken in certain Central Indian States and in Khandesh, and the Bombay Government

has granted a 12 months' option to a company over a forest in the Satpuras for the extraction of the gum oleo-resin.

Tapping operation has been conducted during the year in the North Khandesh Division with the object of supplying bulk samples of the crude gum oleo-resin for purposes of further detailed examination at the Indian Institute of Science, Bangalore, as well as by a Bombay firm.

Rosha Grass Oil.—As a result of this enquiry the Bombay Government has purchased a steam distillation plant which has been erected in the North Nasik Division and which has been handed over to a local contractor for working. In the Nimar Division of the Central Provinces, a lease for extraction of Rosha grass has been granted to a company, who propose erecting an up-to-date steam distillation plant.

It is also understood that the improved type of still has been purchased and will be introduced for future working in the Melghat Division of Berar during the coming season. The first season's work will be carried out under the supervision of the Divisional Forest Officer.

Woods suitable for—(i) Paving Blocks.—The experimental wood-paving laid down by the Bombay Municipality is being extended and further supplies of Teak and Xylia paving blocks have been purchased from the Southern Circle.

(ii) Cotton and Jute Bobbins, Shuttles and Picking Sticks.—Visits were paid to a number of Mills during the year and information collected regarding supplies and prices as well as results of experiments on Indian timbers. The question has now been taken up by the Forest Utilization Circle in the United Provinces and an Experimental Bobbin factory is being erected at Bareilly, the working of which should prove the feasibility or otherwise of supplying Indian-made articles.

(iii) Rifle Stocks.—Two visits were paid to the Ishapore Rifle Factory during the year. A further detailed examination of the timber of *Terminalia bialata* showed that the condemnation of this timber based on the previous year's samples was premature and rifles stocked with this timber were prepared and sent to the School of Musketry, Pachmarhi, for service tests. These tests proved, however, that the timber possessed insufficient strength to withstand rough handling and it has in consequence been rejected for the purpose. *Pterocarpus marsupium* samples have been prepared and remain to be tested. *Albizzia Lebbek* was subjected to test and finally rejected on account of interlocked grain and the consequent difficulty of working the timber to a smooth surface.

(iv) Three Ply.—The question of making Three Ply is now engaging the attention of several companies in Assam and Bengal as well as on the Wes Coast. A visit was paid to the Surma Valley Sawmills, where an up-to-date plant has been erected and very promising results obtained, it having been found possible to utilize all kinds of inferior class timbers for the purpose.

(v) **Casks.**—In the course of a tour in South India, made by the Assistant Forest Economist, information was collected regarding experiments carried out in the North Kanara Division with the object of ascertaining the most suitable caskmaking timber available in the Bombay Presidency. These experiments are still in progress, but the condition of the sample barrels indicated that of the 11 timbers under test *Adina cordifolia, Grewia tiliaefolia, Dillenia indica,* and *Odina Wodier* may be expected to give the most satisfactory results.

Further information was collected on this subject in connection with the supply of White Cedar (*Dysoxylum glandulosum*) timber on the Malabar Coast, this timber being considered the cask timber par excellence for the export of coconut oil to Europe.

The Forest Utilization Circle of the United Provinces is now manufacturing casks made of *Terminalia tomentosa* and *Anogeissus latifolia,* which timbers have been found quite suitable for the purpose.

(vi) **Boot-lasts, Leather-cutting-blocks and Curriers' beam-faces.**—These enquiries arose during the year in connection with the Government Boot Factory at Cawnpore, the objects being to replace imported timbers with suitable Indian substitutes.

Boot-lasts are made of Beech and Maple. As a substitute *Lagerstroemia Flos-Reginae* has been found suitable, though at present the price at which timber can be supplied from Chittagong and elsewhere is said to preclude the possibility of its use for the purpose.

Leather cutting blocks are of two kinds, plain circular and composite oblong. For the plain circular blocks Tamarind was found suitable, but it being found impossible to obtain adequate supplies of this timber, a number of other timbers have now been recommended for test, of which *Mesua ferrea* has proved suitable. The composite blocks are made of Maple and an apparently quite suitable substitute has been made by the Utilization Circle, United Provinces, in the form of a block made of *Anogeissus latifolia* while *Adina cordifolia* and *Terminalia tomentosa* are also under trial. The Curriers' Beam-faces are made of *Lignum Vitae,* an extremely hard wood and *Homalium tomentosum, Mesua ferrea* and *Hardwickia binata* have been recommended as substitutes and are under trial.

(vii) **Ornamental Panels.**—An exhibit of specially prepared and polished panels comprising 21 species has been collected with a view to ascertain which species of timber would be most suitable for the purpose. All the species may be said to have turned out well, though panels of *Populus euphratica, Ulmus Wallichiana, Quercus serrata, Choloroxylon Swietenia, Carallia integerrima, Cordia vestita, Dalbergia latifolia, Dalbergia Sissoo* and *Pterocarpus dalbergioides* have proved markedly ornamental.

(viii) Canes for Ordnance and Ammunition Baskets.—At the request of the Ordnance Department a collection of the more important canes available in commercial quantities from various parts of India was undertaken and submitted for test. Reports on the canes submitted show that the following canes from Assam are considered suitable for Ordnance purposes : *Calamus floribundus, Calamus latifolius, Calamus Guruba, Calamus tenuis, Calamus flagellum, Calamus leptospadix*, and *Daemonorops Jenkinsianus.*

Destructive Distillation of Wood.—As a result of experiments carried out up to date it has been considered inadvisable to proceed further at present with the intricate question of wood distillation. It is understood that large scale experiments are shortly to be undertaken in South India, which should demonstrate the feasibility of the industry in this country.

At present attention is being concentrated on improved methods of charcoal making and the possibility of making Charcoal Briquettes for which purpose an experimental Briquette making plant has been designed and an order placed for its manufacture. The problem at present is to discover a suitable binding material, the pressure required and the fineness to which the charcoal has to be ground, and experiments will be conducted in this connection as soon as the plant is available.

ZOOLOGY.

I.—GENERAL ZOOLOGY AND PHYSICAL ANTHROPOLOGY.

BY

N. ANNANDALE, D.Sc., F.A.S.B.,

Director, Zoological Survey of India.

Research.—A large part of the research work carried out during the year has also been devoted to the freshwater molluscs and their Trematode parasites. In this work we have had the hearty co-operation of Dr. Baini Prashad, Officiating Director of Fisheries, Bengal, Bihar and Orissa. Dr. F. H. Gravely has continued his work on the Indian spiders and has published an important monograph on the Passalid beetles. Mr. S. W. Kemp, while devoting his attention largely to the Trematode parasites of water-snails, has at the same time done further systematic work on the Decapod Crustacea, while Dr. B. L. Chaudhuri and Mr. E. Brunetti have also continued their investigations on the fish and the flies respectively. Captain R. B. Seymour Sewell, I.M.S., whose services have been temporarily transferred to the Zoological Survey of India, is carrying on and elaborating Mr. Kemp's work on the Trematodes, while the latter is on leave in Europe.

Publications.—The following publications have been issued during the year:—

"Records of the Indian Museum," Volume XIV.
"Records of the Indian Museum," Volume XV, Parts III-V.
"Records of the Indian Museum," Volume XVI, Parts I-V.
"Memoirs of the Indian Museum," Volume VII, Nos. 1-2.

Library.—The additions to the library during the year number 1,064. 280 books and periodicals were purchased, 658 received in exchange and the rest presented.

Collections.—The collections have on the whole remained in good condition, but owing to the depletion of the staff for various reasons it has been found very difficult to cope with their proper preservation.

Galleries.—For the same reason as above it has not been found possible to do anything in the public galleries except to maintain the old exhibits in good order.

Papers, etc., on Indian Zoology.—The list of papers that have a direct reference to Indian Zoology has been prepared as usual by Dr. B. L. Chaudhuri. References to insects have been omitted, as it has been decided, in order to avoid duplication, that entomological literature shall be dealt with in its entirety in the report of the Imperial Entomologist.

ZOOLOGY.

II.—ECONOMIC ZOOLOGY.

Part I.—Agricultural Entomology.

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,

Imperial Entomologist.

It should be noted that, in compliance with orders of Government that the Report on Agricultural Entomology in India during the year ended 30th June 1919 should not exceed four pages, exclusive of bibliography, only a very brief summary of the work done at Pusa and in the Provinces can be given here.

I.—Work at Pusa.

Insect Pest.—Numerous observations have been made and a fuller account of these will be found in the Scientific Report of the Pusa Research Institute for this year. The following abstract shows the main crops and insects dealt with :—

Cotton.—Experiments were continued to determine the relative immunity of cotton varieties against attack of insect pests. Work on Cotton Bollworms (*Earias* spp. and *Platyedra gossypiella*) has been continued and other insect pests have been studied.

Rice.—Work on borer pests has been continued. A new Halticine pest was discovered, its grub boring into the stems of rice and millet seedlings from outside and causing a regular "dead-heart."

Sugarcane.—Work on the borer pests of sugarcane and allied Gramineous plants was continued, and the results have been summarized in a paper read at the Third Entomological Meeting. Over thirty different borers have now been discriminated and of these twelve distinct species had previously been confused together under the name *Chilo simplex*.

An unusual outbreak of Dynastine beetles occurred on the Kamrup Sugarcane Farm in April, apparently due to unusual drought in the spring months of 1919.

Indigo.—Investigations regarding the parasitization of Indigo Psylla (*Arytaina isitis*) were continued.

Mulberry.—The disease known as "Tukra" or "Kokra" has been definitely ascertained to be caused by a mealy-bug, *Pheuacoccus hirsutus,* Green which has been studied at considerable length.

Fruit-Pests.—Work was continued, especially on pests of apple, and numerous new pests were discovered and observations made on them. Fuller details will be found elsewhere.

Life-histories of Insects.—Besides the various insects mentioned above, a large number of insects has been reared and observations made on their life-histories and habits.

Monohammus versteegi, a longicorn borer in orange stems in Assam, has been found to have one generation annually, whereas the larva of another (unnamed) longicorn, boring in jack stems in Sylhet, lives for two or three years. *Cryptorrhynchus gravis,* a serious pest of mango fruits in Eastern Bengal and Assam, has been found to lay its eggs in the fruits, and not in the flowers, as was supposed. *Heliothis peltigera* was found in some numbers on safflower and is probably a specific pest of this crop.

Grain Storage Experiments.—These have been concluded and the result written up in a paper read at the Third Entomological Meeting.

Protection of Wood against Termites.—These experiments were continued and the results to date embodied in a paper read at the Third Entomological Meeting.

Lantana Work.—This work was continued in Assam, the Punjab, the United Provinces, Bihar, the Central Provinces and Madras, and was concluded on the 31st March 1919. A complete report has been submitted for publication as a Memoir.

Bees, Silk and Lac.—The work was continued on previous lines.

Illustrations.—Coloured plates and black and white figures of numerous insects studied during the year were prepared.

Insect Survey.—Steady progress was made in additions to and arrangement and identification of the collection, which is now a large and important one and continues to expand at a rapid rate. Thirteen collections of insects were sent out during the year for identification by specialists.

The Third Entomological Meeting was held at Pusa from 3rd to 15th February 1919, and was well attended by delegates from India, Ceylon and Egypt. Over ninety subjects, mostly dealt with in written papers, were laid before the Meeting which also passed various resolutions. A full Report has been prepared and submitted for publication.

II.—Work in the Provinces.

Madras.—The following pests were studied during the years.—*Longitarsus gripennis* on pepper in Malabar, *Hispa armigera* (control demonstrations)

in South Kanara, distribution of *Pempheres affinis*, investigation of *Spodoptera mauritia* in Kistna district, and investigation of *Schoenobius bipunctifer* in Kistna and demonstrations of possible means of control. Various insects were reared and their life-histories studied. The usual routine of rearing and selling disease-free eggs to silkworm rearers in Kollegal was carried out.

Bombay.—The flower-buds and capsules of *Hibiscus cannabinus* were attacked badly by larvae of *Rapala scintilla*, a new pest. The flowers of *Moringa pterygosperma* were attacked by larvae of *Noorda blitealis*. Spraying with Paris Green was found successful against *Arbela* larvae boring in *Bassia latifolia* trees. *Chaetodacus zonatus* was reared from ripe berries of sandalwood, and observations were made on the occurrence of this fly in mango fruits at Poona. *Dichocrocis punctiferalis* was reared from pomegranate fruits and unripe *juar* heads. An egg-parasite on the Bruchid attacking *Dolichos lablab* was reared out. Some work was done on rice-pests at Ratnagiri.

Central Provinces.—Observations were made on pests of sugarcane, including *Sesamia inferens* and *Telicota augias*. *Agrilus acutus* was found attacking *ambadi*. The life-cycle of *Stromatium barbatum* was confirmed to be two years at Nagpur. *Laphygma exigua* did considerable damage to linseed in the Nagpur District and also attacked various other crops. Experiments were made with an Andres Maire trap and with an Ant Exterminator.

United Provinces.—The attack of *Platyedra gossypiella* on cotton-seed during the winter of 1918-19 was unusually light, perhaps due to the drought of the preceding summer.

Punjab.—Insect-pests of cotton were studied. Mulberry silk-worm eggs were distributed for rearing.

Bihar and Orissa.—Observations have been made on a Microgasterid parasite of *Agrotis ypsilon* and endeavours are being made to breed it in order to inoculate the first brood of the *Agrotis* larvae.

Bengal.—The use of cloth bags to protect mango fruits during April was found to be a preventive of attacks of *Cryptorrhynchus gravis*. Some control work was done on *Diacrisia obliqua* on jute at Dacca.

Assam.—No scientific work is reported.

Burma.—Observations were made on pests of cocoanut, palmyra and talipat palms consequent on a report from the Excise Department on the Bud-rot of palms. Red worms (Tubificidae ?) on Ngachima paddy were studied and specimens were sent to the Imperial Bureau of Entomology, London, for identification. The durian borer, the castor mealy-bug and the pests of custard apple tree were also studied. An inquiry was begun into the present condition of the silk industry and it was found that it could not be resuscitated on modern lines.

III.—Native States.

Travancore.—A general survey of crop-pests was made and observations were carried out on various miscellaneous pests.

Mysore.—Control measures against *Amsacta albistriga* have been carried out in four centres under regulations drawn up under the Pest Act. Experiments have been continued with a wash against *Xylotrechus quadripes.* Other pests studied have included cane-borers, *Diacrisia obliqua, jola* ear-head fly, Bruchids and Mango-hoppers.

Hyderabad.—
Kashmir.— } No scientific work is reported.

Baroda.—A few borers were collected from sugarcane and cereals. Both *Earias fabia* and *E. insulana* were found to occur in cotton bolls.

IV.—Other Entomological Work.

Indian Tea Association.—Work was continued on tea pests, (especially *Helopeltis theivora*) and on pests of the green manure plants used on tea estates.

South Indian Planting Districts.—A summary of the insect pests observed during the last two years was read at the Third Entomological Meeting.

A microlepidopterous larva boring in tea stems and eating the bark was received and is under rearing at Pusa; it appears to be a new pest.

ZOOLOGY.

II.—ECONOMIC ZOOLOGY

Part II.—Forest Entomology.

BY

C. F. C. BEESON, M.A., I.F.S.,

Forest Zoologist.

Insects of the Sal.—(*a*) *Hoplocerambyx spinicornis.* - The large heartwood borer has been under observation in the epidemic zone in Thano forest, Dehra Dun Division. Permanent observation plots of 50-60 acres were established and the distribution of the attack surveyed; in its present stage of development the main attack is diffuse without foci or centres of dispersal. Four compartments were completely cleared of attacked trees as an experimental test of control, and a depot maintained to observe the gross emergence of the beetles. Field experiments were duplicated on a smaller scale in open air cages at the Insectary.

Larvae were reared in tubes to determine the influence of moisture on the larval and pupal metabolism. A new fungic disease of this insect was discovered and identified as *Botrytis bassiana ;* the disease appears to be an important natural check, and is probably the primary cause of local decrease and apparent migration [*cf.* last year's report]. The emergence of the beetle was found to result directly from the effect of the moisture-content of the heartwood on the atmosphere of the pupal chamber, the percentage of moisture in the wood being in its turn influenced by rainfall and the relative humidity of the atmosphere. These experiments are being repeated.

(*b*) *Other heartwood borers, etc.*—Additional records of the distribution, food plants and life-cycles of species of *Aeolesthes, Diorthus, Dialeges, Derolus, Plocaederus,* etc., have been obtained in the field and insectary. Special attention was paid to the secretion of lime in the Malphigian tubes of larvæ of these genera, and the utilisation of this material for the construction of opercula to close the pupal chamber. A paper offering explanations of the evolution and function of the calcareous opercula was read before the Indian Science Congress in January 1919; this is now in the press for publication as a Forest Bulletin.

(c) *Shot-hole borers.*—It has been determined that the shot-hole borers of sal are mostly polyphagous and that their range extends into forests beyond the habitat of that tree.

Insects of the Teak.—(a) *Duomitus ceramicus.*—In April-June 1919 teak plantations and natural forests in Pyinmana, Katha, and Shwegu Divisions were visited and stem analyses of 250 trees, in 7 localities, carried out. Data relating to the girth-beehole incidence were obtained which fully confirmed last year's observations as to the correlation between these two factors. In the early years of the life of a plantation the degree of beeholing is directly proportional to the girth of the tree, but after a variable period the current annual beehole increment increases at a much faster rate than the girth increment. Trees up to a maximum of 45 inches girth and of 49 years old show a steady increase in the beehole increment with no indications of a later decrease. Mature trees of the higher girth classes show a lower degree of beeholing (relatively to the present rate of increase in pure teak stands) due, apparently, to their lower attractability in old age rather than a recent increase or extension in the abundance of the borer.

The factors rainfall, fire-protection, thinnings, underplanting, undergrowth, admixture, etc., were studied in connection with the annual incidence; no constant correlation between any or all of these factors and fluctuations in the annual incidence is traceable. Parasitism is at present an unknown factor; attack by woodpeckers is very low. More extended collection of œcological data by stem-analyses and the determination of locality factors is necessary before an artificial control of the pest can be discovered.

Although the present season's work has produced alarming figures for the annual index of attack in plantation teak, yet a comparison with corresponding indices for pure natural teak reveals no great difference, and it may be possible that the operation of natural control factors is as effective in natural regeneration as in planted forest.

Insects of the Toon.—An account of the life history of the toon shoot and fruit borer with suggestions for its control is now in the press as a Forest Record.

Miscellaneous Pests.—During the year 111 consignments of insects, comprising 2,300 specimens, were received from Divisional Officers and others, including many species reported as pests for the first time. There now exists a mass of new records of host-plants, types of damage, distribution, etc., which are to be collated and published. Three instalments, comprising the families, Anthribidæ—Curculionidæ, of an annotated list of the food-plants and distribution of forest insects, were issued in the Indian Forester, during the year.

The borers of numerous species of timber trees with their parasites and predators have received attention during the year; over 15,000 specimens were bred out in the insectary cages.

A note on the life histories of Prionine beetles (Cerambycidæ), with technical descriptions, was prepared for issue as a Forest Record, and is now in the press.

In February 1919 the Forest Zoologist attended the third Entomological meeting held at the Agricultural Research Institute, Pusa. Papers were read on the following subjects—(1) Some Problems in Forest Insect Control, (2) Breeding cages for wood borers and (3) Decimal classification of entomological literature.

Insect Collections.—Specimens of Mesopotamian and Indian dragonflies were identified by Major Fraser, I.M.S., and various orders by the Imperial Entomologist, Pusa. Collections of Tachinidæ, Tenthredinidæ and Siricidæ, Curculionidæ and families of Lepidoptera were despatched to specialists for identification during the year.

Mr. T. R. Bell, Chief Conservator of Forests, presented a large collection of beetles, moths and butterflies; specimens of beetles from the Imperial Entomologist, Pusa, and of butterflies from Mr. A. E. Osmaston, Deputy Conservator of Forests, are acknowledged.

VETERINARY SCIENCE.

BY

A. LESLIE SHEATHER, B.Sc., M.R.C.V.S.,

Director and First Bacteriologist, Muktesar.

Shortness of staff, a large increase in the demand for the products of this Laboratory, and difficulties connected with supplies and labour, have contributed to reducing the amount of time that could be given to research work.

Rinderpest.—The question of increasing the yield of the anti-rinderpest serum occupied the attention of the staff and experiments regarding the length of time for which hides remain infective under varying atmospheric conditions are being continued.

Hæmorrhagic Septicæmia.—Experiments similar to those with Rinderpest hides are being carried out.

Dourine.—The testing of samples of sera from suspected cases of Dourine has been continued by the Second Bacteriologist and reports have been furnished to Civil and Military Veterinary Officers on 152 specimens as follows:—

Positive.	Doubtful.	Negative.
14	12	126

Contagious abortion.—Only a few samples of serum have been tested during the year.

Johne's Disease.—Materials from two suspected cases of Johne's Disease have been received at the Laboratory. Examination yielded a positive result in both instances. The specimens came from Bettiah (Bihar). Fresh attempts are being made to cultivate the organism.

Tuberculosis.—A number of strains of tubercle bacilli are under cultivation and a series of inoculation experiments with cattle and buffaloes has been undertaken.

Piroplasmosis.—Time did not permit of any study being made of this disease.

Parasitic worms.—A new species of worm causing fatal gastritis in calves was detected and a Bulletin published containing a description of it.

A parasitic worm occurring in the larynx and pharynx of cattle and buffaloes has been examined and an account of it has been submitted for publication.

Reports from Veterinary Colleges and Provincial Laboratories.—Nothing worthy of record has been received from the Veterinary Colleges and various Provincial Superintendents of the Civil Veterinary Department.

MEDICAL RESEARCH.

By

The Hon'ble Major-General W. R. EDWARDS, C.B., C.M.G., M.D., K.H.P., I.M.S.,

Director-General, Indian Medical Service.

The following is an extract from the Report of the Scientific Advisory Board of the Indian Research Fund Association for 1918-1919.

Diabetes.—The results obtained by Lieutenant-Colonel McCay and his co-workers are briefly as follows :—

The percentage of sugar in the blood of Bengalies is high, and is higher in the fat and indolent classes. Sugar tolerance is poor in these and a state of concentration of sugar in the blood and excretion of sugar in the urine can be easily induced in these people and is found naturally among a large percentage of them. Lieutenant-Colonel McCay shows that the assimilation of carbohydrates in the diet is never perfect in a normal human being and that a pathological condition can be induced even in healthy people by errors in diet. Thus there are all stages present between an occasional presence of sugar in the blood, a mild form of Diabetes and the severer conditions leading to death. Over-feeding with carbohydrates is in itself sufficient to produce diabetes, but attention is directed to the assistance given in the production of this disease by the development of morbid conditions in the stomach and intestines and by the conditions which lead to the appearance of Oxyluria.

Coma among Indian diabetics is due, not to acidosis which is the common cause in Europe, but to true Nephritis and is in fact uræmic coma.

Plague.—The inquiry into plague preventive measures under Dr. Chitre is yielding very interesting and instructive results specially on three lines (1) the determination of what natural grains make the best baits to attract rats, (2) the determination of the best poison to mix with these baits, and (3) experiments on the most reliable types of rat traps. Further it has been found by Dr. Chitre that rats under godown conditions become very wary and increasingly difficult to poison or catch in traps.

Investigations in Karachi.—Major (now Lieutenant-Colonel) Greig, C.I.E., I.M.S., with his assistants, Captain Maitra, I.M.S., and Captain Wrench, R.A.M.C., continued investigations financed to a certain extent by the Research Fund Association. They have contributed papers on the Anti-beri beri value of certain food stuffs. In January 1919, a most

valuable paper on influenza written by Major Greig in collaboration with Captain Maitra appeared in the Indian Journal of Medical Research. It showed that the reason for the non-success of various workers in the isolation of bacillus of influenza is, that this organism lodges in the remote sinuses communicating with the nose in which situations they found it almost invariably, sometimes in association with the pneumococcus.

Lately, in continuation of some work done in America, experiments have been started to determine whether the mixture of Co. 2, with air does or does not lead to better cultural conditions for the growth of certain organisms such as the meningococcus and the gonococcus.

Deficiency Diseases.—Lieutenant-Colonel McCarrison was placed on this investigation in 1918. He has shown that profound changes both functional and organic are produced not only in the central nervous system but in all the organs of the body by "Deficiencies" in food. The most striking is the hypertrophy of the adrenals and the atrophy specially of the thymus, spleen and testicle in avian beri-beri.

We have received an important contribution also from him on the influence of deficiency of accessory food factors on the muscular and nervous tissues of the walls of the intestine. These investigations are of the greatest importance. They have received very laudatory notice, in some of the British Medical Journals.

Influenza Enquiry.—The services of Captain Malone, I.M.S., have been obtained to study the pathogenic organisms associated with the influenza epidemic in India. He worked first in Calcutta and lately in Bombay. This inquiry promises to yield useful results especially if the epidemiology of influenza can also be studied. It is hoped that Major Morison will shortly be available for this.

Hook-worm Disease.—This work has continued in Trichinopoly and Dindigul under Dr. Mhaskar. The incidence of hook-worm infection is nearly 100 per cent. in Tanjore, Trichinopoly, Madura, Ramnad and Tinnevelly. He has found that thymol in 60 grain doses is a most efficient anthelmintic and chenopodium oil in 48 minim doses is effective, but he draws attention to its occasional bad after effects.

Investigations are also in progress by Dr. Mhaskar, in conjunction with Father Caius on certain chemical problems in connection with anthelmintics.

From 3rd June to 9th October 1918, 37 sub-assistant surgeons were trained in hook-worm diagnosis by Dr. Mhaskar.

Leprosy.—Dr. Sudhamoy Ghose continues his work under the general supervision of Sir Leonard Rogers. Oils of *Hydnocarpus*, codliver oil, and oil of *Asteriostigma macrocarpa* have been under investigation and pure sodium morrhuate is being prepared.

Meanwhile the Mission to Lepers has instituted a trial into the comparative effects of chaulmoogra oil used intramuscularly and of sodium gynocardate prepared from chaulmoogra oil by Sir Leonard Rogers.

Bio-chemistry.—Mrs. D. Norris has continued her inquiry at the Central Research Institute, Kasauli, where she is studying the relationship existing between the bacterial yield of culture media and their chemical composition and mode of preparation. The problems involved are of extreme practical importance at the present time, not only in conjunction with large demands for vaccines, for troops overseas and in India, but also with the growing demands from the civil population of India. Her last report shows that caseinogen may be a better "substrate" than meat extracts, for Media. It is also cheaper. The results of the practical application of this will be awaited with interest as on it depends the cheaper manufacture of vaccine.

Miscellaneous.—Dr. Mackenzie Wallis is continuing in England his investigations into the food value of ground nuts on animals.

He also proposes to pursue the subject of the value of various chloramines for sterilising water.

Malaria.—The Research Fund Association has given financial assistance to the work of Captain Acton āt the Dagshai Malarial Convalescent Depôt under the orders of the Director of Medical Services in India. Captain Acton in conjunction with Dr. Curjel and others have submitted reports showing that in their opinion quinine has a specific action on malignant malarial parasites, but not on benign tertian.

Entomology.—The work of Mr. Awati into the bionomics of house flies continues in Nagpur.

A very interesting paper on Sand Flies in Lahore by Mr. Mitter was published in the April Number of the Indian Journal of Medical Research.

Mollusc Survey.—This survey is under the direction of the Zoological Survey of India. The workers are Dr. Annandale, the Director, Dr. Kemp, and Mr. Gravely. Dr. Annandale has surveyed the molluscs in certain parts of the Madras Presidency and has reported recently on the mollusc distribution in Seistan, Baluchistan, North-West Frontier Provinces of India and the Punjab. Very recently Dr. Kemp and Mr. Gravely have submitted a report on the natural schistosomes present in the molluscs obtained from the Madras Presidency and on certain infection experiments they made on these molluscs with material obtained from a person suffering from urinary bilharziosis. These experiments are of the utmost importance if we are to determine the possibility of the spread of bilharziosis in India.

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Bangalore, Ceylon, Haldummulla, Wadduwa, pp. 356-357 ; *I. cyanura*, n. sp., Kandy, pp. 359-360; *I. dimelaena*, Wlk.-*cardoni*, Bourg ; *I. flavibuccis* n. sp., Mandar (W. Bengal), Bhutan, p. 361 ; *I. luteipes*, n. sp., Nilgiris, Anamalais, pp. 361-362 ; *I. indicola*, n. sp., Nilgiris, p. 362 ; *I. rostrifera*, n. sp., Anamalais, p. 363 ; *I. nitida*, n. sp., Karachi, Lahore, p. 364 ; *I. varicornis*, n. sp., Tavoy, Sadiya, p. 366 ; *I. atriceps*, n. sp., Burma, p. 367 ; *I. decolor*, n. sp., Karen Hills, Tavoy, p. 368 ; *I. dasytoides*, n. sp., Karen Hills, pp. 370-371].

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Belgaum, p. 188 ; *Lamprothripa gilvaria*, n. sp., Khasis, p. 196. Lithosiadae : *Spilosoma melanochroa*, n. sp., Nilgiris, p. 216. Phalaenoididae for Agaristidae, p. 216].

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" " " . Descriptions of new Pyralidæ of the Sub-family Pyraustinæ. (*Ann. Mag. Nat. Hist.* (9) *II 181-196* ; 393-407.) [*Psara*. Snell (1875) supersedes *Pachyzancla*, Meyr. p. 187 ; *Loxostege*, Hb. supersedes *Phlyctænodes*, p. 189. *Hapalia pulverulenta*, n. sp., p. 400. Ambalangoda ; *Pyrausta infuscalis*, n. sp., p. 405, Sikkim.]

" " " . Some small Families of the Lepidoptera which are not included in the Key to the Families in the Catalogue of Lepidoptera Phalænæ, a list of the Families and Sub-families of the Lepidoptera with their types, and a Key to the Families. (*Novit. Zool. xxv* 366-394.) [Tascinidæ (Neocastniadæ), p. 377 ; *Tascina nicevillei*, Hmp., Tenasserim, p. 377. List of 89 Families and a Key to the same.]

HOOD, J. DOUGLAS . On some new Thysanoptera from Southern India. (*Insec. Inscit. Menstr. vii* 90-103, t. 3-4.) [*Scirtothrips dorsalis*, n. sp., Coimbatore, pp. 90-91 ; *Perissothrips*, n. g., type *parviceps*, pp. 91-92, *P. parviceps*, n. sp., on *Ailanthus* at Coimbatore, pp. 92-93, t. 3 ff. 3-6 ; *Rhipiphorothrips cruentatus*, n. sp., Coimbatore, Peradeniya, pp. 94-96 ; *Neoheegeria indica*, n. sp., Coimbatore, pp. 96-98, t. 3 ff.

1-2; *Arrhenothrips*, n. g., type *ramakrishnae*, p. 98, *A. ramakrishnae*, n. sp., Coimbatore on *Mimusops*, pp. 99-101, t. 4, ff. 1-2; *Liothrips ordinarius*, n. sp., Coimbatore on *Sesbania*, pp. 101-103, t. 4 ff. 3-4.]

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JARDINE, N. K. . . The Tea Tortrix (*Homona coffearia*, Nietner), (*Ceylon Dept. Agric., Bull. No. 40, pp. 38, 14 figs.*)

JERMYN, T. . . . Notes on Mimicry in Oriental Butterflies (*Proc. Entom. Soc. London, 1917, pp. ix-xiii*).

KUNHI KANNAN, K. . An instance of Mutation: *Coccus viridis*, Gr., mutant from *Pulvinaria psidii*, Mask. (*Trans. Ent. Soc. London, 1918, pp. 130-148, t. 5-8.*) [*Coccus colemani*, n. sp., Mysore and Coorg, pp. 135-136.] [See also Green.]

KUNHI KANNAN, K. . Pulse Beetles (Store forms). (*Mysore Dept. Agric. Ent. Bull. 6; pp. 31, 18 figs.*)

" " . Pulse Beetles in the Store (*Mysore Agricl. Calendar 1919, pp. 13, 16-17, figs.*)

" " . The Pest Act against *Kumblihulas* (*l. c., pp. 21, 24.*)

LAIDLAW, F. F. . . A list of the Dragonflies recorded from the Indian Empire with special reference to the Collection of the Indian Museum. Part II (contd.) The Family Agrionidæ. (*Rec. Ind. Mus. xvi 169-195, 4 figs.*) [*Ischnura annandalei*, n. sp., Shan States, pp. 175-177; *Rhodischnura*, n. g., type *nursei*, Morton, p. 177; *Agriocnemis pieris*, n. sp., Castle Rock, pp. 179-180; *A. splendidissima*, n. sp., Cochin, Castle Rock, pp. 180-182; *Aciagrion olympicum*, sp., Darjiling distr., pp. 184-186, f. 1; *A. hisopa*, Selys, subsp. *occidentalis* nov., Cochin, Castle Rock, p. 186; *A. tillyardi*, n. sp., Cherrapunji, p. 187; *Ceriagrion coeruleum*, n. sp., Darjiling dist., pp. 189-190; *Pseudagrion bengalense*, n. sp., Calcutta, pp. 192-193.]

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MARSHALL, G. A. K. . Notes on *Alcides*, Schönh. (*Ann. Mag. Nat. Hist.* (9) *ii 152-158.*) [*Alcides delta*, Pasc., from Ceylon low-country, pp. 152-154; key to *delta* group, pp. 153-154; *A. ephippiatus*, n. sp., Dikoya, Bogawantalawa, Kandy, pp. 154-155; *A. signatus*, Boh., is Indian, p. 158.]

MEYRICK, E. . . Description of South American Microlepidoptera. (*Trans. Entom. Soc. Lond., 1917, pp. 1-52.*) [*Peronea flexilineana*, Wlk., recorded from Brit. Guiana, p. 14; *Crocidosema*, Z., note on, p. 16.]

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" " . . . . Notes on the Derbidæ in the British Museum Collection. I. Zoraidinæ. (*Ent Mo. Mag., liv, 173-177, 202-207.* [*Pamendanga distanti*, n. sp., pp. 202-203 Maskeliya; *Zoraidz kirkaldyi*, n. sp., pp. 205-206, Kandy (=*cumulata*, Dist., *nec* Wlk.); *Phenice*, Westw., type *fasciolata*, Boh, p. 207.]

" " . . . . II. Derbinæ. (*l. c. 227-243.*) [Keys to sections and genera: *Phenice mœsta*, Westw., placed in *Proutista* (Zoraidinæ), p. 235; *Phra pictipennis*, Dist., placed in *Mysidioides*, Mats, (p. 242); *Vinata*, Dist., *Kermesia*, Dist. *Alara*, Dist., and *Nisia*, Mel., placed in Cixiidæ (p. 243).]

MUNZ, P. A. . . . A venational study of the suborder Zygoptera (Odonata) with keys for the identification of genera. (*Mem. American Entom. Soc., No. 3, pp. 78, figs. A-C, tabs. 20.*)

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PAIVA, C. A. . . . Aquatic Rhynchota from the Southern Shan States. (*Rec. Ind. Mus., xiv, 19-32, t. 8-9.*) [*Velia y-alba*, p. 20, t. 8 f. 1; *Microvelia burmanica*, pp. 21-22, t. 8 f. 2; *Onychotrechus lyra*, pp. 24-25, t. 8 f. 3; *Ventidius distanti*, p. 25, t. 8 f. 4; *Enithares intha*, p. 27, t. 8 f. 5; *Nychia infuscata*, p. 28, t. 8 ff. 6, 6a; *Plea quinquenotata*, p. 29, t. 8 ff. 7, 7a; *Plea areolata*, pp. 29-30, t. 8 ff. 8, 8a; *Corixa unicolor*, p. 30, t. 8 f. 10, t. 9 f. 2; *Corixa*; *septemlineata*, p. 30, t. 8 f. 9, t. 9, f. 1; *Micronecta, substriata*, p. 31, t. 8 f. 11, t. 9 f. 3; *M. soror*, p. 31, t. 8 f. 12, t. 9 f. 4; *M. fulva*, p. 32, t. 8 f. 13, t. 9 f. 5; n. spp.]

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" " AND SINÉTY, R. DE. Réaction chromatique et non chromatique de quelques Phasmides (Orthopt.) aux excitations dépendant de la lumière. (*Bull. Biol. France Belg.*, lii, 177-283, figs., tab. 2.) [Experiments included *Carausius morosus*, Br., and *C. furcillatus*, Pant., from S. India.]

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POULTON, E. B. . . . *Papilio polytes romulus*, Cram, from the extreme South of India and from the mainland opposite Singapore Island. (*Proc. Ent. Soc. London, 1917, pp. lxxx-lxxxiv.*)

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" " . . . The description and life-history of a new species of *Anopheles* that breeds in holes in trees. (*Rec. Ind. Mus., xv, 123-127, t. 17.*) [*Anopheles annandalei*, n. sp., from Sureil (5000 ft.), Darjiling District.]

PRASHAD, BAINI . . Contributions to the Anatomy of Aquatic Diptera. No. 1 (*l. c., 153-158, t. 19.*) [Larva and pupa of *Chaoborus manilensis* (*Corethra asiatica*); larva and pupa of *Dixa montana.*]

PROUT, L. B. . . New Lepidoptera in the Joicey Collection. (*Ann. Mag. Nat. Hist. (9), ii, 412-418.*) [*Anisodes* (*Brachycola*) *clandestina*, n. sp., pp. 414-415, Khasis, Pundaluoya, Penang, Perak, Singapore, Sarawak: *Cyclidia substigmaria*, Hb., *superstigmaria*, n. subsp., pp. 415-416, Dharmsala, Kulu, Sikkim, Burma, etc., and *intermedia*, n. subsp., Tibet.]

" " . . . New species and forms of *Geometridæ.* (*Novit: Zool., xxv, 76-89.*) [Hemitheinæ: *Berta angustimedia*, n. sp., Khasis, p. 76; Sterrhinæ: *Synegiodes obliquifascia*, n. sp, Khasis, p. 78. *Timandra nelsoni*, n. sp., S. India, Ceylon, pp. 78-79; *Timandra oligoscia*, n. sp., Tibet, p. 79.

RAMAKRISHNA AYYAR, T. V. Some foreign insect pests which we do not want in India. (*Agricl. Journ. Ind., xiv, 500-511, t. 14-16.*)

" " . Some notes on the habits and life-history of the stem weevil attacking Cambodia Cotton. (*Pempheres affinis*, Faust.) (*Madras Agricl. Dept. Yearbook, 1918, pp. 1-13, 4 figs.*)

" " Some South Indian Coccids of economic importance (*Journ. Bombay Nat. Hist. Soc., xxvi, 621-628, tabs. 1-4.*

RICARDO, G. . . . Notes on the Asilidæ: Sub-division Asilinæ. (*Ann. Mag. Nat. Hist. (9), iii, 44-79.*) [*Machimus assamensis*, n. sp., Assam, pp. 46-47; *M. coerulescens*, n. sp., Kumaon, p. 47; *M. dubius*, n. sp., Kumaon, pp. 47-49; *M. hirtipes*, n. sp., Khasis, p. 49; *M. indianus*, n. sp., Kumaon, Thandiani, Masuri, pp. 50-51; *M. khasiensis*, n. sp., Khasis (Lower Ranges), pp. 51-52; *M. montanus*, n. sp., Kotagiri pp. 52-53; *M. nigrinus*, n. sp., Kumaon, pp. 53-54; *M. parvus*, n. sp., Trincomali Dambulla, Horawapatana, Mahagangy, and, Kenaratyodes [? Henaratgoda] (Ceylon) and Biserat (Siam), pp. 54-55; *M. tibialis*, n. sp., Dehra Dun and Bhowali, pp. 55-56; *Neoita*

mus griseus, Wied, ? Ceylon, p. 58; *N. philus*, Wlk., Sylhet, Khasis, Sikkim, Taungu, Tenasserim, redescr., pp. 58-59; *N. longistylus*, Wied., New Guinea, Gilolo, Batian, Siam and Nicobars, synonyms, redescr., pp. 59-60; *N. ceylonicus*, n. sp., Trincomali, p. 60; *N. grandis*, n. sp., Bhowali, p. 61; *N. hindostani*, n. sp., Kumaon, pp. 62-63; *N. inornatus*, n. sp., Masuri and Punjab, pp. 63-64; *N. pulcher*, n. sp., Kandy and Haragama, pp. 65-67; *N. tropicus*, n. sp., Kumaon, pp. 69-70; *N. tarsalis*, n. sp., Kandy, Bentota, Trincomali and Badulla, pp. 70-72; *Heligmoneura gnava*, Wulp., Kandy, Khasis, Siam, Borneo, distinctions, pp. 73-74; *H. indianus*, n. sp., Kotagiri, pp. 74-75.]

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ROTHSCHILD, LORD . . Catalogue of the Parnassiinæ in the Tring Museum. (*Novit. Zool., xxv, 218-262.*) [*Parnassius apollo* subsp?, Tibet, p. 244; *P. jacquemontii jacquemontii*, Bdv., Himalaya, Ladak, p. 250; *P. jacquemontii himalayensis*, Elw., Afghanistan, Kulu, Sikkim, p. 251; *P. jacquemontii chitralensis*, Mo., Chitral, p. 251; *P. jacquemontii mercurius* Gr-Grsh., Tibet, p. 251; *P. jacquemontii tatsienluica*, Verity, Ta-tsien-lu, E. Tibet, p. 252; *P. tibetanus*, Rühl, Tibet, p. 252; *P. epaphus epaphus*, Kashmir, p. 252; *P. epaphus poeta*, Oberth., Tibet, p. 252; *P. epaphus* subsp. ?, Tibet, p. 252; *P. epaphus sikkimensis*, Elw., Chumbi Valley, Sikkim, p. 252; *P. epaphus* subsp., Native Sikkim, p. 253; *P. epaphus* subsp.?, Tibet, p. 253; *P. epaphus* subsp., Chitral, p. 253; *P. hardwickii*, Gray, Kashmir to Sikkim and Tibet, p. 253; *P. szechenyi germanæ*, Aust., "Tibet!!," p. 253; *P. orleans orleans*, Oberth., China, E. Tibet, p. 254; *P. orleans groumi*, Obth., Tibet, p. 254; *P. delphius diaphana*, Verity, Tibet, 255; *P.*

delphius macdonaldi, subsp., nov., Tibet, p. 256; *P. delphius stenosmus*, Honr., N. Kashmir, p. 256; *P. delphius stoliczkanus*, Feld., Ladak, p. 256; *P. delphius* subsp. ?, Kulu, p. 257; *P. delphius lampidius*, Fruhst., Kambajong, p. 257; *P. acco acco*, Ladak, p. 257; *P. acco gemmifer*, Fruhst., Sikkim, p. 257; *P. acco baileyi*, South, Tibet, p. 257; *P. imperator imperator*, Tibet and Yunnan, p. 257; *P. imperator intermedius*, Roths., Tibet, p. 258; *P. imperator augustus*, Fruhst., Tibet, p. 258; *P. charltonius* subsp., Kashmir, p. 258; *P. charltonius deckerti*, Verity, Chitral, p. 258; *P. charltonius bryki*, Hande, Garhwal, p. 258; *P. simo acconus*, Fruhst., Kambajong, Tibet, Sikkim, p. 259.]

" " . On a new species of *Stictophthalma*. (*Novit. Zool., xxv, 310.*) [*S. tytleri*, n. sp., Kindat (Burma) and Sebong (Manipur).]

ROTHSCHILD, LORD . Catalogue of *Zerynthiinæ* and allied genera in the Tring Museum, with critical notes. (*Novit. Zool., xxv*, 64-75.) [*Leptocircus curius curius*, p. 67; *L. meges virescens*, p. 68; *Teinopalpus imperialis* forms *imperialis*, *himalaicus* and *imperatrix*, p. 69; *Armandia lidderdalii lidderdalii*, p. 69.]

" " . Description of a new genus and two new species of Heterocera. (*Ann. Mag. Nat. Hist.* (9), *iii, 487-488*). [*Spilosoma ignivagans*, n. sp., pp. 487-488, Tali (Yunnan).]

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SPEYER, E. R. . . The Distribution of *Xyleborus fornicatus*, Eich (Shot-hole Borer of Tea). (*Ceylon Dept. Agric. Bull. 39, 34 pp.*).

SWINHOE, C. . . . New species of Indo-Malayan Heterocera, and descriptions of genitalia, with reference to the Geographical Distribution of species resembling each other. (*Ann. Mag. Nat. Hist.* (9), *ii*, *65-95, tabs. 7-11.*) [*Amphipyra magna*, Wlk., from Punjab distinct from *pyramidea*, Linn., pp. 66-67; *Stictoptera tongluana*, Swinh, from Solomon Isds, not Sikkim, p. 68; *Maurilia instabilis*, Butl.,=*iconica*, Hmpsn., part (*nec.* Wlk.), Kurseong, Khasis, p. 71; *Carea intermedia*, n. sp., p. 73, t. 8, f. 7, Kandy, Palnis; *Carea subtilis*, t. 8, f. 6, male genit.; *Carea innocens*, n. sp., Palnis, Bandora, pp. 74-75; *Argiva* and allies separated from Catocalidæ, p. 81; *Patula macrops*, habits, p. 81, male genit., t. 11, f. 24; *Patula*, structure, p. 87; *Patula ipsa*, n. sp., Kandy, p. 88, t. 11, f. 25; *Capnodes asulca*, n. sp., Khasis, p. 89; *Bertula adra*, n. sp., Jaintia Hills, p. 92; *Bomolocha olypea*, n. sp., Mahableshwar, p. 93; *B. uniformis*, n. sp., Jaintia Hills, p. 94.]

" " . . . On the geographical distribution of the Genus *Cosmophila*, a Noctuid of the Family Gonopteridæ. (*Ann. Mag. Nat. Hist.* (9), *iii*, *309-314, t. 9-10.*) [*C. erosa*, Hb., is American, not Indian; *C. xanthindyma*, Bdv., from Dar-es-Salam and Karachi; *C. indica*, Gn., from Assam, Bombay, Gooty, Palnis and South India; male genitalia described and figured.]

" " . . . New Lycænids and Hesperids and two new species of the Noctuid Family Acontiidæ (*l. c.*, *pp. 314-319*). [*Lycænopsis trita*, n. sp., Murree, pp. 314-315; *Tajuria drucei*, Swinh., female descr., Shan States; *Ruralis pavo*, Nicev., male descr., Simla; Hesperiadæ—*Arunena*, n. g., type *nigerrima*, n. sp., Khasis, p. 317.]

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	Linn. Soc. Zool., xxxiii, 203-385.) [Experiments with Indian butterflies, pp. 379-381.]
TOWNSEND, C. H. T. .	New Muscoid genera, species and synonymy. (*Insec. Inscit. Menstr., vi, 157-182.*) [*Eophyto*, n. gen., type *ceylanica*, pp. 163-164; *E. ceylanica*, n. sp., Peradeniya, p. 164.]
TROUP, R. S. . . .	Experiments in the pollarding of *Butea frondosa* for lac cultivation. (*Ind. For., xlv., 1919, pp. 223-233.*
TURNER, A. JEFFERIS .	Observations on the Lepidopterous Family Cossidæ and on the Classification of the Lepidoptera. (*Trans. Entom. Soc. London, 1918, 155-190, 58 figs.*)
TURNER, R. E. . . .	New species of Hymenoptera in the British Museum. (*Trans. Entom. Soc. Lond., 1917, pp. 53-54.*) [*Elis* (*Mesa*) *nursei*, Turn., Simla, redescr., p. 60; *Cryptosalius*, n. g., *rava*, Bingh., from Bangalore and Coimbatore, p. 76; *C. pandiyanus*, n. sp., Coimbatore, pp. 77-78.]
" " . . .	Notes on Fossorial Hymemoptera. XXXVII. On some Sphecinæ in the British Museum. (*Ann. Mag. Nat. Hist.* (9), *iii*, 393-397.) [*Sphex* (*Ammophila*, auct.) *basalis*, Smith = *nigripes*, Sm., p. 396; *Ammophila apicata*, Bingh., is a *Chlorion* (*Isodontia*).]

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BELIN	Traitement des lymphangites contagieuses du cheval par la pyotherapie. (*Bull. Soc. Cent. de Med. Vet., lxxii, 1919, pp. 73.*)
BOQUET, A. AND NEGRE, L.	Polymoryhisme et determinisme morphogenique du cryptocoque de Rivolta. (*Annales Instt. Past., xxxiii, March 1919, pp. 184.*)
" " " " AND ROIG, G.	First attempts to prepare a vaccine against Epizootic Lymphangitis. (*Bull Soc. Path. Exot. Vol. xi, No. 7, July 1918.*)
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" " . . . Au sujet du traitement de la gale du dromadaire. (*Bull. Soc. Cent. de Med. Vet., lxxi, 1918, pp. 481.*)

" " . . . Sur le traitement des trypanosomiases au Soudan, (*Bull. Soc. Cent. de Med. Vet., lxxi, 1918, pp. 482.*)

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